ENGINEERING NEWS

MR. CHARLES LATIMER, for 14 years at the head of the Engineering Department of the New York, Pennsylvania & Ohio Railroad, and otherwise well known to all our readers, died suddenly in Cleveland, O., March 25, from the effect of a stroke of apoplexy, in the 61st year of his age, he having been born in Washington, D. C., Sept. 7, 1827. As befitted his pure and deeply religious nature the stroke came to himw hen upon his knees engaged in his usual morning prayers, at 8.30 A.M. He was unable to rise and soon became unconscious, dying at 2.55 P.M. of the same day. He leaves a family of four children. His wife died thirteen years ago. We postpone until next week a fuller sketch of his life and character in order that we may present a portrait with it.

IT now looks as if the plan for an elevated road on the south side of Chicago was going through. The city ordinance for the road as amended requires the tracks to be situated adjacent to and parallel with an alley, and the understanding now is that property east of the alley between Wabash Ave. and State St. will be used. The promise is made that, instead of its taking two years to complete the road, it will be completed in half the time and be in operation. The ordinance is regarded as one of the most stringent ever passed, and it is important as establishing a precedent to elevated railway enterprises for the future under which roads of the kind will hereafter be required to buy their right of way, instead of using the streets. The company does not like the ordinance, but will accept it.

ONE of the largest of the real estate companies which are attracting now-a-days so large an amount of capital, is the International Company of Mexico which was formed to develop the resources of Lower California. The company bought 17,000,000 acres of land on this peninsula, about all the northern half; has earned by surveys about 4,500,000 acres in other Mexican States and on the completion of the surveys will be entitled to about 14,000,000 acres more. The concession which this company has secured from the Government includes rights for steamer lines, railways, and various works of public improvement. It has already founded a town at Ensenada, 70 miles south of San Diego, Cal., which has now a population of about 3,000, and considerable progress has been made on surveys of proposed railway lines. The company is a Connecticut corporation. EDGAR V. WELLES of Hartford, Ct., is President, and among the directors are RICHARD A. ELMER of the American Surety Co., of this city, GEO. H. SISSON of San Francisco and LUIS HULLER of the City of Mexico. The head office of the company is at 160 Broadway.

THE bill recently introduced to carry out Mayor HEWITTS' rapid transit scheme provides that the Mayor, Comptroller and Commissioner of Public Works shall be a Board to determine plans for a road or roads in all their details. Within four weeks the Common Council must approve or disapprove, and either the consent of the property owners or an order of the Supreme Court must also be obtained, as provided in existing laws. They are then to advertise for proposals to construct and operate the road for a term of years, the money being raised by issue of 3 per cent. city bonds and the rental being at least 5 per cent. with other details as originally outlined, but the objectionable feature of offering the contract to the New York Central without competition is done away with.

The Panama Railroad Co. is being reorganized. The Panama Canal Co. has completed its payment for the stock of the company and now assumes control. The Canal Co. retains Mr. R. A. THOMPSON alone out of the old directory; other places for the present will be filled by Canal employés. An effort is being made to induce Gen. JOHN NEWTON to accept the position of President of the railway company in place of Mr. I. G. MCCULLOUGH. Gen. NEWTON, however, disclaims any intention of resigning from his present position.

THE Brooklyn Bridge cable traffic was again interrupted this week for several hours by a breakage of machinery in the engine room, it is stated, but fortunately it was not in the rush hours. The bill for the reorganization of the Board of Trustees is still pending in the New York Assembly, but it is likely to pass without opposition when reached, so far as yet appears.

MONTREAL is not only protecting itself by levees from floods in the St. Lawrence due to ice, but erecting costly pumping stations at various points. One of the stations is also designed to rid the city of its sewage. The essential features of the work are: An iron penstock gate, to be closed when the river is at flood; the sewage dammed up by the closing of the gate and to be conveyed to the pumping station by a brick flume and distributed by six smaller flumes to four centrifugal pumps having a combined discharge of 72,000 galls. per min. The sewage will be raised by these pumps 15 ft., and will then be discharged into the same sewer from which it was pumped at the other side of the penstock gate. The motive power will be two pairs of automatic engines of 300 horse-power each.

TWO slight shocks of earthquake occurred in Nashua, N. H., March 27, sufficiently violent to awaken people and shake things up a little, with the usual rumbling noise.

THE Lehigh Valley R. R. Co. has succeeded in getting its bill through the New Jersey Legislature relieving it from its obligations to maintain the Morris Canal as a water-way for boats. As the railroad company still preserves its right to the valuable feeders to this canal, it is generally supposed that the bed of the canal and these feeders will be utilized in bringing pure water to some of the towns of northern New Jersey now suffering from a lack of proper supply. As the canal was practically useless for traffic this seems to be the best and a highly proper use to put it to; the towns need the water and can very well do without the canal.

THE City Council of Cleveland, O., has passed an ordinance for burying the electric wires, by a decisive majority. The ordinance includes wires of all kinds, and fixes the time of so doing within 3 years at the latest. The Cleveland Telephone Company asked for and was granted the privilege for 25 years of constructing and maintaining underground conduits.

THE Senate Committee on Commerce, in response to a resolution of inquiry as to the right and expediency of Congress assuming control of the erection of bridges over navigable rivers within State limits, has reported that there can be no question as to the right of Congress to absolutely control the construction of bridges across navigable streams, nor is this power limited or affected by the fact that such streams are entirely within the limits of a State.

The report further says there are a great many navigable streams within the limits of the respective States, which should be left to the control of State Governments. At the same time Congress should never surrender its power to control the erection of bridges over such streams whenever that power should be exercised. It was therefore recommended that the *statu quo* should be maintained.

THE spring floods and freshets have commenced in earnest and reports of serious damage done are coming in from all parts of the country. Washouts and landslides have occurred on a large number of railroads. Rivers are rising and there is apprehension of very considerable injury by floods, while in the South heavy rainstorms have helped to swell the rivers and streams. It is feared that the great flood of the Mississippi, which occurred in 1882, will be repeated this spring. In many western rivers the ice has broken up and formed dams, causing floods. In Alabama trains were caught between washouts and were abandoned. Storms have also occurred on the coast, and the channel being dug from Shinnecock bay, on Long Island, to the sea, is reported to have been filled up with sand. Dams have been destroyed at Rockville, Conn., Willimantic, Conn., East Blackstone, Mass., New Brunswick, N. J., North Monson, Mass., and near Eau Claire, Wis. A wind and rain storm did much damage in Georgia and Tennessee March 20. Very extensive washouts have occurred on the Missouri Pacific between Leavenworth, Kan., and Kansas City, Mo.; and at Kansas City a big landslide occurred on the bluff facing the Union depot, a heavy retaining wall built by the city along the face of the bluff being nearly destroyed. A cyclone damaged buildings and crops in Gregg Co., Tex., March 25.

THE iron bridge being built across the Rouge river, near Point-au-Chene, Ore., collapsed March 20 in consequence of the false works being taken down before the structure had been properly secured. It was a single span of about 300 ft.——The following accidents are due to the floods: two bridges over the Medomack river, Maine, between Union and Washington, have been washed away; a trestle on the New London Northern, at Palmer, Mass., was washed away and a railroad and a highway bridge at North Monson damaged. The Memorial bridge at Concord, Mass., has been wrecked. The West Shore bridge at Fort Hunter, N. Y., has been washed away, a loss of about $35,000; also a bridge on the Ontario & Western at East Branch, N. Y.; also a railroad bridge at Cobleskill, N. Y. A bridge at Milford, Pa., was carried away by an ice gorge, March 22, and the toll gate keeper and his wife were killed. The New York Lake Erie & Western bridge over the Delaware at Mount Hope was washed away March 26. Several Missouri Pacific bridges below Napton, Salins Co., have been washed away, and a bridge on the same road at Billingsville, Mo., has been damaged. About 50 ft. of a trestle on the Nashville & Chattanooga, between Cowan & Sherwood, Tenn., were carried away March 26. Several small bridges and trestles on the Louisville & Nashville have been wrecked or damaged. The Burlington & Missouri River bridge over the Loup, on the Columbus line, has been partly destroyed, and the Northern Pacific bridge over the Rosebud, near Miles City, Mont., gave way under a freight train, having been weakened by the flood. In Texas a number of bridges and trestles have been damaged, and throughout New England many bridges have been washed away or wrecked.

This is a big list for one week.

THE first train on the King's County Elevated Railway, Brooklyn, N. Y., was run over the line from Classon Ave. to Fulton ferry, on March 24. On the train were WILLIAM F. SHUNK, Chief Engineer; ANDREW BRYSON, Assistant Engineer; O. F. BALSTON, Division Engineer; Gen. J. JOURDAN, President, and a number of public men. The road will probably be opened for traffic in May.——Engines and rolling stock have also been put on the tracks of the Union Elevated Railway, in Brooklyn, and the Myrtle Ave. division will probably be opened soon. These lines will pour a very considerable additional traffic on the bridge at once, and within a year a heavy and still growing further addition, so that it looks as if it would not be long before 18-car trains would have full employment even without allowing every passenger a seat.

IT is now announced that the Nicaragua canal surveying expedition will probably not return as a body, but those who wish to leave may do so, while others may be continued in employment, as the construction of the canal will follow closely upon the completion of the survey. The first work in this direction will be the building of a wharf at the harbor of Greytown, which may be utilized to land machinery, etc., needed for prosecuting the work. Mr. MAXWELL, chief of the hydrographic party, and Mr. J. S. FORD are now engaged on this project. The borings on the site of the great dam show very favorably, rock and very tough hardpan being found throughout.

THE most serious railroad accident of the week was a collision on the Northern & Northwestern Railway, near Severn Bridge, Ont., Canada, March 22. A freight train collided with a snow plow. Five men were killed and 3 injured.——A head collision occurred near Wampum, Pa., March 23, between two passenger trains on the Pittsburg & Lake Erie Railroad. One man was killed and 9 injured. The accident was due to incorrect train orders.——A crossing accident occurred near Chicago, March 27, a Toledo, Wabash & Western Railroad freight train running into the rear sleeper of a Michigan Central Railway express. The latter had the right of way, and was protected by signals. Several passengers were injured, but none severely.

The Proportions of Pins and Eye-Bars.

BY CHAS. F. STOWELL, C. E., BRIDGE ENGINEER TO THE NEW YORK STATE RAILROAD COMMISSION.

A theory is good or bad just in proportion as it does or does not agree with and explain known facts. Judged by this criterion it must be admitted that the common theory of bending moments and fibre stresses in pins is far from satisfactory. It is no uncommon thing to find the fibre stresses, as calculated, running up to 100,000 lbs. per sq. in. and over, especially in old bridges in which the pins were proportioned for shear and bearing only. We know that if any such stress did occur the pin would surely fail; hence it is admitted that the computations give erroneous results, and the explanation offered is that by reason of the slight bending of the pin the stresses in the eye-bars which it connects are re-adjusted, some of the bars being overstrained and others correspondingly relieved,

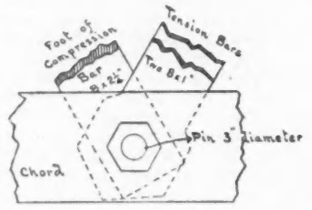


Fig. 1.

the total result being that the bending moment on the pin is largely reduced. But suppose the bending is produced by only one or two bars so that a readjustment of the stresses becomes impossible? What then?

An example of this is shown in Figs. 1 and 2, which illustrate a joint of the Moorabool viaduct, in Australia. This bridge is a double track, deck, triangular truss structure, containing ten continuous spans of 130 ft. each. Fig. 1 shows a side view of a lower chord joint, and Fig. 2 a plan of same, giving arrangement of parts on the pin. The stress in the compression and tension members is the same, being 210,600 lbs. in each, and the members make angles of 60° with each other and with the

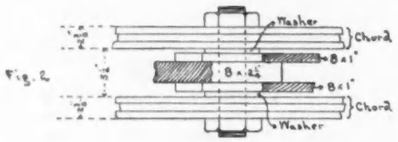
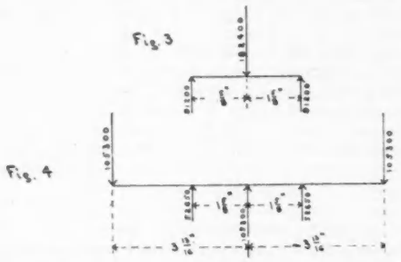


Fig. 2.

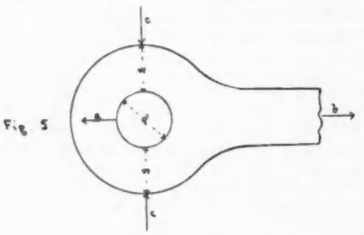
chord, hence the vertical component of the stress in each member is 182,400 lbs., and the horizontal component 105,300 lbs. Fig. 3 shows the couples producing vertical bending which amounts to 148,200 in.-lbs. at the center of the pin, and Fig. 4 the horizontal couples, producing a bending moment of 315,900 in.-lbs. at the center. The resultant center bending moment is 349,000 in.-lbs., which would produce a fibre stress of 131,600 lbs. per sq. in. on the pin.

Now in this case, any "readjustment" of stresses in the bars is obviously impossible. Whatever stress comes down the compression member must go up the two tension members and be equally or very nearly equally distributed between them. There can be no doubt about the stresses. We know that the modulus of rupture of the pin is two-thirds or three-fourths of the computed stress and less than half of it would strain the pin beyond its elastic limit, or in other words permanently bend it. But we know also that the bridge has been in constant use under heavy traffic for more than 20 years, and that so far no signs of failure in the joint are apparent. The logical conclusion must be that no such stresses as are calculated really exist, and that therefore the theory on which the calculations are based is not good.*

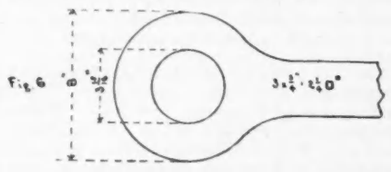
After all, when one comes to consider it, a theory based on the assumption that stresses are concentrated at the centers of eye-bar heads, or that the center of stress is there, could hardly be expected to give satisfactory results, for the very good reason that the stresses are not so concentrated. Consider a pin passing through the eye of a bar. As long as no pressure is exerted between the two the bar may be considered as uniformly in contact with the pin throughout its thickness. But it must be remembered that the pin is elastic and the moment any pressure, however slight, is exerted between them the pin necessarily begins to bend. And as soon as the pin begins to bend the intensity of pressure, which is generally assumed to be uniform over the



area in contact, becomes disturbed, being diminished at the center and increased at one or both edges of the surface of contact of the eye-bar head, according as the points of resistance of the pin are on one or both sides of the eye-bar which is doing the pulling. The centers of pressure then, instead of being uniformly at the centers of the eye-bar heads are really never there, but are either thrown towards one edge or broken up into two, each of which is somewhere near the edge of the eye-bar head. The effect of this movement of the center of pressure is to shorten the lever arms of the bending couples and correspondingly reduce the bending moment on the pin. The greater the pull of the eye-bars the greater will be the deviation of the centers of pressure from their assumed position and the greater the variation of the theoretical stress on the pin from the actual. To make an accurate computation of the bending stress would be exceedingly difficult if not absolutely impossible. The best that can be said for the common rule is that it will surely give a closely packed chord and will guarantee a safe joint as far as the pin is concerned.



But there is another point to be considered. In avoiding the Scylla of too small pins is there not danger of running into the Charybdis of too large



eyes? Although all the ordinary text-books give rules for making eye-bar heads, none of them, as far as the writer is aware, give any discussion of the stresses to be provided for in the head. It is not difficult to compute such stresses in the sides of the head at least.

In Fig. 5, let w represent the width of iron on each side of the pin hole and t its thickness, d, the diameter of pin hole and s, the stress in the bar.

The stress s, is applied at the point and in the direction of the arrow a, and is balanced by an equal and opposite force denoted by the arrow b. This stress is transferred equally through the sides of the head producing a uniformly distributed tensile stress therein to the amount of $\frac{s}{2tw}$ pounds per square inch. But the application of the stress s, at the point a, instead of in a line with the side of the head, tends to elongate and flatten the eye and is equivalent to applying on each side of the head a bending force, denoted by the arrows c, whose moment is $\frac{s}{2}\times$ distance from the center of the eye to the center of gravity of the side of the head. In other words, a force whose moment is

$$\frac{s}{2}\ \frac{w+d}{2}=\frac{s\,(w+d)}{4}.$$

This bending force is resisted by the moment of internal resistance of the side of the head about its center of gravity, which is $\frac{t\,w^3}{12}+\frac{w}{2}=\frac{t\,w^2}{6}$.

Hence the maximum fibre stress (compression in the outside and tension in the inside fibres) in the side of the head due to the bending force is

$$\frac{s\,(w+d)}{4}\times\frac{6}{t\,w^2}=\frac{3\,s\,(w+d)}{2\,t\,w^2}.$$

Adding to this, the direct tensile stress previously found, we get for the total maximum fibre stress per square inch at the inner surface of the sides of the head,

$$\frac{3\,s\,(w+d)}{2\,t\,w^2}+\frac{s}{2\,t\,w}=\frac{s\,(4\,w+3\,d)}{2\,t\,w^2}.$$

Now let us take an example: Fig. 6 represents the head of an actual eye-bar in a recently built bridge. In this case

$$w=\tfrac{1}{2}\,(8-3\tfrac{9}{16})=2\tfrac{7}{32}$$
$$t=\tfrac{3}{4}$$
$$d=3\tfrac{9}{16}$$

s (assumed at 10,000 lbs. per sq. in.) = 22,500.

Substituting these values in the preceeding formula we find for the maximum tensile stress on the inside fibres of the sides of the eye *a value of* 72,800 *lbs. per sq. in.*

It will be observed that, for a given stress in the eye-pin, the maximum fibre stress in the head increases as the size of the pin is increased; that it increases as the width, w, of the side of the head becomes greater but in a less ratio than the moment of resistance of the side of the head, and that it varies inversely as the thickness of the head. The fibre stress therefore may be reduced in either of three ways (a) by diminishing the size of the pin (at the expense of the bending stress thereon) or (b) by increasing the width of the head or (c) by increasing its thickness (also at the expense of the bending stress on the pin).

This formula for fibre stresses in eye-bar heads is not put forth with any pretension to that cocksureness which is sometimes claimed for the calculations of fiber stresses in pins. Nevertheless it seems probable that it may perhaps account for the number of failures of eye-bar heads formed of the usual proportions before the bar itself gives way. Mr. JAS. G. DAGRON is authority for the statement that out of a large number of eye-bars made by three leading bridge companies, selected at random from bars made for actual use in bridges and tested to destruction, 29 per cent. of the steel, and nearly 44 per cent. of the iron bars broke through the pin-hole or in the head, although the excess of metal through the pin-hole over the body of the bar was 50 per cent. in steel bars and more than 50 per cent. in iron. On the other hand the Edge Moor Iron Co. regularly proportions eye-bars with an excess of 50 per cent. through the eye when the pin is less in diameter than the width of the bar and only 40 per cent. when the diameter of pin is greater. They guarantee these bars to break in the body rather than in the head and the tests appear to justify their claim. For instance, a steel bar of their manufacture which had a body 5×1 in. in size with pin-holes for $5\frac{7}{16}$ in. pins and heads $11\frac{1}{2}$-in. wide, broke in the body of the bar developing an elastic limit of 41,200 lbs., and an ultimate strength of 61,100 lbs. per sq. in. The excess of metal through the eyes here was much less than 40 per cent., and according to the formula the tensile fibre stress in the head ought to produce rupture long before it occurred in the body of the bar. But in this case as well as in all similar ones, the metal in the heads was strained beyond its elastic limit, although it did not actually break as soon as the bar itself. The eyes in these bars were always elongated, the amount varying from an eighth of an inch to an inch and a half. Now since the greater part of the stress in the side of the head is due to the bending moment, it is possible that the resistance of this portion of the bar may be due to the fact that in

*It may not be necessary to add that the writer disclaims any intention to defend the Moorabool Viaduct or to advocate the use of such extremely bad details. The example is given merely to illustrate how far away from each other theory and fact sometimes get.

beams subject to transverse bending "*after the elastic limit is passed*, in consequence of the flow of the material, it is highly probable that the law of the variation of stress intensity changes and becomes such that, with the same greatest intensity as the surface of the solid beam, the resisting moment is considerably increased." It would be very interesting to know whether the elastic limit in these cases was reached first in the body of the eye-bars or in their heads, since it is this quality and not the breaking strength which governs the use of eye-bars in bridges.

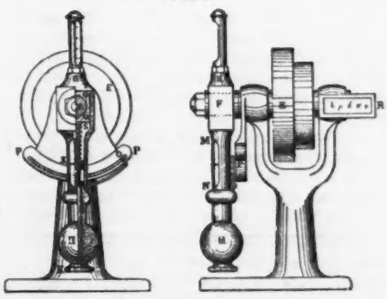
At any rate there appears to the writer an obvious inconsistency in proportioning pins for a computed maximum fibre stress of 15,000 or 20,000 lbs. per sq. in., when the very fact of their being so large, produces in the eye-bars stresses from three to five times as great, computed on a theory, at least as reasonable as that for pin bending.

Recent Researches in Friction.*

In recent scientific researches, the investigation and study of the laws of friction must certainly be classed amongst the most important. Until lately, erroneous and vague views were entertained, mainly on account of the absence of any well ascertained data based on scientific and practical experiments, although the great importance of the subject was fully realized. This department of applied science claims the careful attention and study of the practical engineer as well as of the theorist, from the fact alone that frictional resistance is a constant and ever-recurring source of waste work; but in order that the student may arrive at a correct conclusion, he must examine the most recent experimental results, for the whole subject has been completely revolutionized within the last few years.

Amongst the first explorers in this field of labor was one of the most original and scientific engineers of the last generation, namely, the late Gen. MORIN, who gave much time to this subject, and obtained results of a very varied nature both with dry and with lubricated surfaces on every possible constructive material. Owing, however, to the extremely low pressure and speeds with which he worked, his results are not regarded as of much value in the

FIGS. 1.

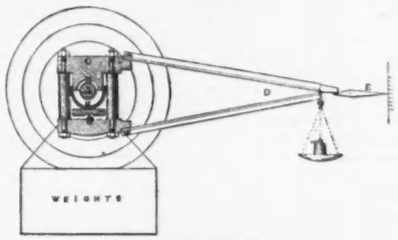


Thurston's Friction Testing Machine.

light of modern experiments, such as those of Prof. THURSTON, Mr. BEAUCHAMP TOWER, M. Inst. C. E., under the auspices of the Institution of Mechanical Engineers, and of Mr. W. STROUDLEY, M. Inst. C. E., who experimented in a more practical manner on the axles of railway trains and locomotives, under conditions similar to those encountered in actual practice. Engineers in America have been working in a similar direction: Mr. WOODBURY on the friction of revolving disks; Mr. WELLINGTON, on the total resistance of trains, which includes the friction on the journals, tires, etc; and last, but by no means least, there are the well-known experiments of Messrs. GALTON and WESTINGHOUSE, on the brake-friction of railway vehicles, the most important of which were carried out on the Brighton Railway with the co-operation of Mr. STROUDLEY.

The author's object in contributing this Paper is, to compare these various results, and to examine the phenomena which have been obtained from a theoretical point of view. The laws of dry friction must be considered from an entirely different standpoint from those of the friction of well-lubricated surfaces, although in some cases it is a very difficult, if not an impossible task to define accurately where the one condition begins and the other ends; for example, some revolving journals, although originally fully lubricated, behave as dry surfaces when the supply of lubricant diminishes. The apparatus used by the most recent experimenters is shown in the illustrations. Figs. 1, represent Prof. THURSTON's machine.

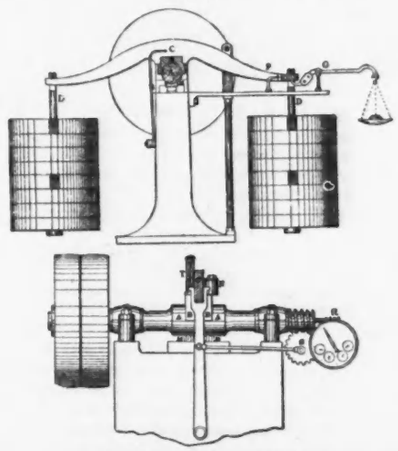
FIG. 2.



Tower's Testing Machine.

F, the journal on which it is desired to measure the frictional-resistance, is driven by a belt running on the pulley *E*. The brass, *G*, is fitted into the upper part of the pendulum *H H*; the desired pressure on the brasses is applied by turning the hand-screw *K*, which compresses the spiral spring *S*; *P P* is a graduated arc transversed by the pointer *O*, which is attached to the pendulum. The quotient of this reading by the total pressure indicated by the pointer *X* gives the co-efficient of friction. On the

FIG. 3.

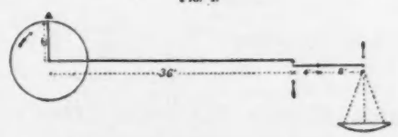


Stroudley's Testing Machine.

top of the brass is a thermometer to register the heat of the journal; *R* is a revolution-indicator; the lubricant is supplied through a small hole at *T*. When the journal revolves the friction on the brass causes the pendulum to be deflected.

Mr. TOWER's machine, Fig. 2, resembles the last in some points, but for the spiral spring a dead weight is substituted to give the desired load on the brass. *A* is the revolving journal, *B* is the brass bearing, carrying the frame *C*, on the lower part of which is a knife edge C^1, situated immediately under the center of the journal, from which is suspended the weights; *D* is a long light angle-iron frame with a scale-pan suspended from its extremity, into which are placed weights to counterbalance the turning moment of the friction. *E* is a pointer and gradu-

FIG. 4.



ated scale to indicate when the whole frame is in its normal position. *H* is an oil-bath into which the bottom of the journal dips, and so keeps up a thoroughly good supply of lubricant.

In Mr. STROUDLEY's machine, Fig. 3, the essential difference from the last mentioned is the arrangement for applying the load to the brass. *A* is the revolving journal, several sizes of which are used corresponding to the various axles of a train. *B* is the brass bearing fitted into the weight-beam C, at each end of which is a knife-edge carrying a weight-suspending link *D*. *G* is a small scale-beam and pan into which weights are placed to counterbalance the moment of the friction. *H* is a small eccentric and wheel, driven by a worm on the main shaft, which keeps the bearing continually moving to and fro to represent the side-play always given on locomotive axles. *M* is an oil-pan which keeps the journal constantly lubricated. *N* is a siphon lubricator. *R* is a revolution indicator. *T* is a thermometer to register the heat of the journal. *P* indicates when the beam is in its normal position.

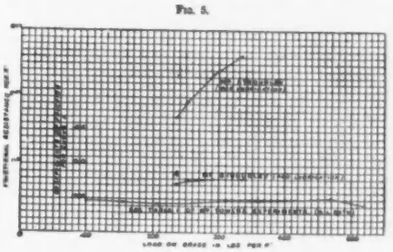
The frictional resistance is calculated thus (Fig 4):

Let x = radius of the journal in inches.

W = the total load on the brass in ozs.

Then with the dimensions as shown, a weight in the

FIG. 5.



Friction as affected by Load.

scale-pan acts at a leverage of $72 \div x$ on the surface of the journal; so that 1 lb. in the pan is equivalent to $\frac{72}{x}$ lbs. frictional resistance on the brass. Then—

$\frac{72}{W x}$ = the coefficient of friction cooresponding to each oz. in the scale-pan.

The total frictional resistance on the brass

$$\frac{72 \text{ (weight in scale-pan)}}{x}$$

The frictional resistance per square inch

$$\frac{\text{Total frictional resistance}}{\text{nominal area of brass}}$$

The nominal area = the length of the journal × the chord of the arc of the brass in contact. The H. P. required to overcome this resistance is calculated by formulas given further on.

By comparing and examining the observed results obtained from these machines, the following laws become apparent.

LAWS OF FRICTION: WELL LUBRICATED SURFACES. (Oil-bath.)

1. *The coefficient of friction with the surfaces efficiently lubricated is from* $\frac{1}{6}$ *to* $\frac{1}{10}$ *that for dry or scantily lubricated surfaces.*

2. *The coefficient of friction for moderate pressures and speeds varies approximately inversely as the normal pressure; the frictional resistance varies as the area in contact, the normal pressure remaining constant.*

3. *At very low journal-speeds, the coefficient of friction is abnormally high; but as the speed of sliding increases from about 10 to 100 ft. per minute, the friction diminishes, and again rises when that speed is exceeded, varying approximately as the square root of the speed.*

4. *The coefficient of friction varies approximately inversely as the temperature, within certain limits, namely, just before abrasion takes place.*

The evidence upon which these laws are based is taken from various modern experiments. That relating to Law 1 is derived from the "First Report on Friction Experiments," by Mr. BEAUCHAMP TOWER.

TABLE X.[1]

Method of Lubrication	Coefficient of Friction.	Comparative Friction.
Oil bath	0.00139	1.00
Siphon lubricator	0.0098	7.06
Pad under journal	0.0090	6.48

With a load of 293 lbs. per sq. in., and a journal speed of 314 ft. per min., Mr. TOWER found the coefficient of friction to be 0.0016 with an oil bath, 0.0097 with a pad, which is six times the amount of friction with the latter. Under the same conditions, Mr. STROUDLEY obtained a coefficient of 0.00961, which is a very close approximation.

The very low coefficients obtained by Mr. TOWER

*A Paper read at a Students meeting of the Institution of Civil Engineers by JOHN GOODMAN, S ud. Inst. C. E. Trans. Inst. C. E. 1886.

will be accounted for by Law 2, as he found that the frictional resistance per square inch under varying loads is nearly constant.

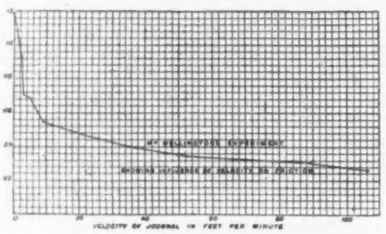
TABLE I.[1]

Load in lbs. per square inch.	520	468	415	363	310	258	205	153	100
Frictional resist. per. sq. in.	0·416	0·514	0·498	0·472	0·464	0·438	0.43	0·458	0·45

It should be noted here that the frictional resistance per square inch is the product of the coefficient of friction into the load per square inch on horizontal sections of the brass. Hence, if this product be a constant, the one factor must vary inversely as the other, or a high load will give a low coefficient, and *vice versa*.

For ordinary lubrication, the coefficient is more constant under varying loads; the frictional resistance then varies directly as the load, as shown by

FIG. 6.



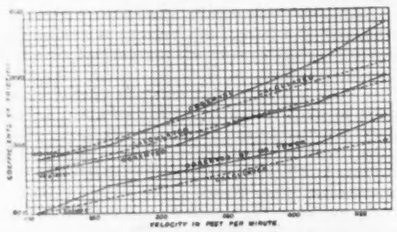
Friction as affected by Low Velocities.

Mr. TOWER in Table VIII. of his report,* and also from the following results obtained by Mr. STROUDLEY with a pad of standard Globe oil, as used for carriage-axles on the Brighton Railway:

Load per square inch on Brass.	Coefficient of Friction.	Frictional Resistance per sq. inch.
Lbs.		Lbs.
333	0·00792	2·639
293	0·00800	2.34
251	0·00770	1·93
237	0·00720	1·70

With respect to Law 3, Mr. A. M. WELLINGTON, of the American Society of Civil Engineers, made a large number of experiments, on journals revolving at very low velocities, and found that the friction was then very great, and nearly constant under varying conditions of the lubrication, load and temperature. But as the speed increased the friction fell slowly and regularly, and again returned to the original amount when the velocity was reduced to the same rate.†

FIG. 7.



Friction as affected by High Velocities.

The following table shows this clearly (Fig. 6):

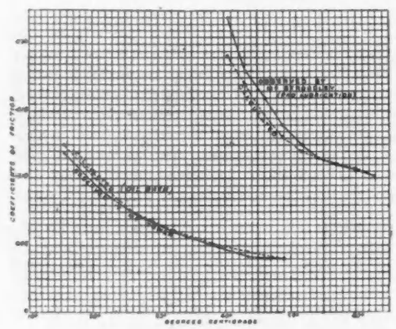
Feet per minute.	0 +	2.16	3.33	4.86	8.82
Coefficient of friction,	0.118	0.094	0.0705	0.0645	0.055
Feet per minute.	21.42	35.37	53.01	89.28	106.02
Coefficient of friction,	0.047	0.040	0.035	0.030	0.0255

It was also found by Prof. KIMBALL that when the journal velocity was increased from 6 to 110 ft. per minute, the friction was reduced 70 per cent.; in another case, the friction was reduced 67 per cent. when the velocity was increased from 1 to 100 ft. per minute; but after that point has been reached the coefficient of friction varies approximately with the square root of the velocity, this law was pointed out by the late Mr. W. R. BROWNE, M. Inst. C. E.[2] The observations are by Mr. TOWER.

COEFFICIENTS OF FRICTION, FOR SPEEDS AS BELOW (FIG. 7).

Feet per minute.	209.	262.	314.	366.	419.	471.	Nominal Load per square inch.
Observed.....	0·0010	0·0012	0·0013	0·0014	0.0015	0·0017	Lbs.
Calculated.....	0·0010	0·00118	0·00123	0·00132	0·00141	0·0015	520
Observed.....	0·0013	0·0014	0·0015	0.0017	0·0018	0·002	468
Calculated.....	0·0013	0·00145	0·00159	0·00172	0·00184	0·00195	
Observed.....	0·0014	0·0015	0·0017	0·0019	0·0021	0·0024	415
Calculated.....	0·0014	0·00157	0·00172	0·00185	0·00198	0·0021	

FIG. 8.



Friction as affected by Temperature.

The variation of friction with temperature is approximately in the inverse ratio, Law 4. Take, for example, Mr. TOWER'S results, at 262 ft. per minute, as shown in the following table:

Temp. Centigrade.	43·4°	37.8°	32·2°	26·7°	21·1°	15·6°
Obs'rv'd	0·0044	0·0051	0·006	0·0073	0·0092	0·0119
Calcul'd	0·00451	0·00518	0·00608	0·00733	0·00964	0·01252

This law does not hold good for pad or siphon lubrication, as then the coefficient of friction diminishes more rapidly for given increments of temperature but on a gradually decreasing scale until the normal temperature has been reached; this normal temperature increases directly as the load per square inch, as shown in the following table taken from Mr. STROUDLEY'S experiments with a pad of rape oil (Fig. 8):

Temperature, Fahrenheit,	105	110	115	120	125	130	135	140	145
Temperature, Centigrade,	40·56	43·34	46.1	48.9	51.7	54·4	57·2	60	62·78
Coefficient,	0.022	0·0180	0·0160	0·0140	0·0125	0·0115	0·0110	0·0106	0·0102
Decrease of coeffic'nt	....	0·0040	0·0020	0·0020	0·0015	0·0010	0·0005	0·0004	0·0002

FIG. 9.

Goodman's Micrometer for measuring Oil Films.

From the above consideration it may be fairly assumed, the friction of lubricated surfaces is very different in nature from the friction of dry surfaces. One essential point is that in well lubricated surfaces the brass and journal are not in contact, but are separated by thin films of oil, the one adhering to the brass, the other to the journal. The resistance, therefore, is due to the shearing action between the two films. There is no doubt whatever but what this film actually exist, for the brass with its load is bodily raised as soon as the journal begins to revolve. The author has not only proved this for himself, but has also measured accurately the thickness of the film with a piece of apparatus of his own design. The experiment was carried out on Mr. STROUDLEY'S machine (Fig. 9), where *A* is a micrometer screw capable of measuring to 0.0001 in., carried by a small bracket fastened to the brass, but electrically insulated from it by paraffined paper. *B* and *C* are terminals for attaching insulated wires to a weak voltaic cell and galvanometer. When the micrometer touches the shaft the galvanometer is deflected; this is set so that there is contact when the shaft is at rest, but immediately it is put in motion the brass with the micrometer is raised and the circuit is broken; the screw is again set to just touch the shaft, when the micrometer indicates the height to which the brass has been raised. The amount was found to vary with the efficiency of the lubrication. With a pad-lubricator it was raised to 0.0013 in. on first starting, and as the films became better developed the friction decreased and the brass was ultimately raised 0.0029 in. It was found by Mr. TOWER that there was an immense pressure of oil between the brass and the journal, equivalent at a certain point to more than double the nominal load per square inch.

In making a similar experiment with Mr. STROUDLEY'S machine, the author found that ordinary lubrication with a pad failed to give any pressure on the gauge, but if the pad was dipped in oil and applied in a dripping condition, the pressure immediately rose, and gradually sank as the oil-supply diminished; thus the pressure-guage became a good indicator of the efficiency of the lubrication. In the same experiment it was found that the coefficient of friction was about 25 per cent. lower when the oil-hole on the top of the brass was closed with a screwed plug, thus indicating that the oil escaped at the apex of the bearing, and so prevented a cushion or film of oil being effectually formed.

With well lubricated surfaces the amount of wear is extremely small, even at high surface velocities; for instance, on the Brighton railway there are many cast-iron eccentric straps working on cast-iron sheaves, which have been running constantly for 12 or 13 years without requiring the slack to be taken up; their surface velocity is about 900 ft. per minute, representing in 13 years a distance of at least 100,000 miles passed over by the surfaces. This excellent result is due to the thoroughly good system of lubrication adopted.

LAWS OF FRICTION: DRY SURFACES.

The following laws, which are based upon the results of modern experiments, appear to govern the friction between dry surfaces:—

1. *The friction between dry surfaces under moderate loads and low velocities, varies directly as the normal pressure between them.*

2. *The normal pressure remaining unchanged, the friction is independent of the area in contact.*

3. *It is always greater on the reversal of direction of sliding.*

4. *It sensibly diminishes with a rise of the temperature.*

1. In the GALTON-WESTINGHOUSE experiments it was found that with velocities below 100 ft. p

[1] Institution of Mechanical Engineers. Proceedings, 1883, p. 651.

[2] *Ibid*, p. 643.

[3] Institution of Mechanical Engineers. Proceedings, 1883, p. 650.

† Transactions of the American Society of Civil Engineers, 1884, vol. xiii., p. 409 *et seq.*

[2] The *Engineer*, 1884, vol. lviii., pp. 57, 58.

minute, and with low pressures, the frictional resistance varied directly as the normal pressure; but when a velocity of 100 ft. per minute was exceeded, the coefficient of friction greatly diminished; from the same experiments Prof. KENNEDY found that the coefficient of friction for high pressures was sensibly less than for low.

2. This law is best demonstrated by arranging an inclined plane of suitable material, and placing on it several bodies of the same weight and similar material, but with different areas in contact; when a sufficient inclination is given to the plane, they will all start sliding together; thus the area in contact does not affect the coefficient of friction.

FIG. 10

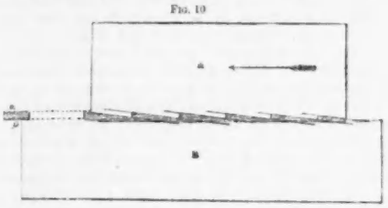


FIG. 11.

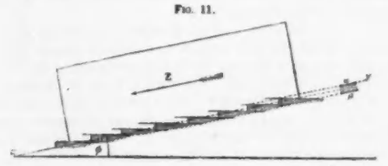
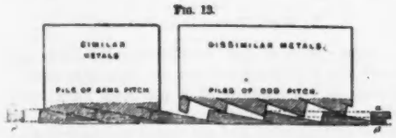


FIG. 12.

FIG. 13.



Diagrams Illustrating the Theory of Friction.

3. This law can be demonstrated by attaching a string to a sliding body on a horizontal plane; the string passes over a grooved pulley to a scale-pan in which are placed weights just sufficient to make the body slide; but if the body be turned round so that its direction of sliding is reversed, the original weights will be insufficient to cause sliding, showing that the friction is greater. This law is also true for lubricated surfaces.

4. In the experiments on brake-blocks, it was found that they became considerably heated after successive applications, and at the same time the coefficient of friction sensibly diminished.

Possibly this may be the reason why the friction diminishes with increased pressures, for the heat generated by friction varies as the normal pressure.

The theoretical consideration of "dry friction" is of a much more complex nature than that of lubricated surfaces, but if it be assumed as a basis that all the surfaces of solid bodies resemble in structure the surface or pile of velvet, many, if not all the difficulties will be easily overcome. However smooth the surfaces may appear, a pile will still be left; for as the original surface is worn away, particles of metal are torn from the main body, each of which will leave its own jagged hole, and constitute a fresh pile as the old one is removed. An illustration of this is seen when a piece of wood is filed transversely to the grain; as long as the filing is continued a rough surface is left. The pile will necessarily partake of all the physical properties of the metal, its tenacity, elasticity, coarseness of grain, etc. The latter property will determine the degree of fineness, or "pitch of the pile," which is simply the relative number of fibers or piles per unit of area.

When two such surfaces are pressed together, the pile will become partially flattened, and will not leave a perfectly smooth surface, but one consisting of minute indentations and projections, the latter on one surface fitting into the former on the other. Hence, before any sliding motion can take place, the projections on the one must mount up and pass over those on the other, which constitute a series of minute inclined planes. But before this motion can take place, a force must be applied to the sliding body, one component of which acts in opposition to the normal pressure; the force required to make a body slide up these inclined planes is the resistance of friction, hence the greater the normal pressure, the greater is the resistance to sliding. If the normal pressure be too great, abrasion takes place, and the resistance is greatly increased, because the force now required to produce sliding must be sufficient to tear the pile or fibres from the metal. Fig. 10 illustrates how the pile causes the frictional resistance, the pile being highly exaggerated to show the effect more clearly. A and B are two masses of metal, of which A slides over B; now it is evident that before any sliding can take place, A must be vertically raised through the distance $a\,\beta$; then while sliding is taking place, A is being constantly raised and allowed to fall through $a\,\beta$. The force required to maintain this motion is the frictional resistance; the blow given at each fall is converted into heat, and hence the heat caused by friction is simply due to the impact of the bodies.

The total amount of work done against frictional resistance may be expressed thus:

Let n = the number of projections, piles or fibers per lineal inch.
Let the space $a\,\beta$ (Fig. 10) = $.\theta$ inch.
Let the normal pressure = $.\Phi$ lbs.; then the work done in making A slide through 1 inch is—

$$W = \frac{n \times \theta \times \Phi}{12} \text{ foot-lbs. of work.}$$

In Fig. 11, let $x\ y$ represent an inclined plane, with a body Z just beginning to slide by its own weight, then $tan\ \Phi$ will be the coefficient of friction; now it is evident that the pile must be flattened by the sliding body, so that the side of each fibre is level, or slightly lower at the tips. hence it follows that the coefficient of friction is the tangent of the angle which the side of each loaded fibre makes with the surface of the plane on flat surfaces.

It will now be seen why the friction is independent of the area in contact, the normal pressure remaining unchanged, as the resistance is only dependent upon the height $a\,\beta$. When the direction of sliding is reversed, the pile, which is already flattened in the original direction, must describe the arc of a circle before it can be flattened in the reverse way (Fig. 12), and then the vertical distance $a\,\beta$, is increased to $m\,n$, which will account for Law No. 3.

If the temperature of the surfaces is high, the pile is more pliable, and consequently becomes more flattened, which reduces the height $a\,\beta$, with a correspondingly diminution of friction.

When the velocity of sliding is very small, the projections on one surface sink completely into the indentation on the other; but when the velocity is increased, the tips of the fibres only come in contact, as there is not sufficient time for the one to sink its full depth into the other, which again reduces the vertical height $a\,\beta$; but in the case of high velocities of revolving bodies, another force comes into operation; so called centrifugal force acts on the pile and stiffens it, as it tends to fly from the center, for the same reason that revolving brushes are always stiffer at high velocities than at low. This stiffening increases the friction, as each pile has to be flattened before passing under the bearing.

The coefficient of friction is always higher with similar, than with dissimilar metals; the reason of this may be seen from Fig. 13; in the second case, the vertical height $a\,\beta$, is considerably less than in the first.

The problem, to find the work absorbed by friction is one which often occurs in practice: it may therefore be useful to consider the method.

Let P = normal pressure in lbs.;
u = coefficient of friction, namely, the ratio of the resistance to the load;
s = space in feet through which sliding takes place;
t = time in minutes during which sliding takes place;
n = number of revolutions per minute;
v = velocity of sliding, in feet per minute;
a = number of square inches of surface in contact;
d = diameter of journal in inches;
W = work absorbed in foot-lbs.

Then for flat surfaces $W = P \times u \times s$.

$$H\,P. = \frac{P \times u \times v}{33{,}000}$$

Cylindrical journals per revolution—

$$W = \frac{P \times u \times 3.1416\ d}{12}.$$

$$H\,P. = \frac{P \times u \times 3.1416 \times d \times n}{12 \times 33{,}000}.$$

The frictional resistance of a sliding body is expressed thus:—

$$P \times u.$$

Frictional resistance per square inch:—

$$\frac{P \times u}{a}.$$

To calculate the $H\,P.$ absorbed by friction in a train—

Let N = the number of square inches (nominal) of bearing surface in the whole train;
$F\,R$ = average or mean frictional resistance per square inch on all the journals;
$J\,S$ = average or mean velocity in feet per minute of all the journals.

$$\text{Then } H\,P. = \frac{N \times F\,R \times J\,S}{33{,}000}.$$

The pull on the draw-bar due to journal friction per ton weight of train—

$$\text{Pull in lbs.} = \frac{u \times 2{,}240}{r}, \text{ where } r \text{ is the ratio of the radius of wheel to the radius of journal.}$$

In calculating the load on the journals of train-axles, it must be borne in mind that the dead-weight of the vehicle on the brass is only a part of the total load; the other factor of total load is the rolling-resistance of the wheels in the direction opposite to that in which the train is traveling; the amount of this second factor is at present unknown, and can only be ascertained by a special experiment; but, however great this pressure may be, the brass does not wear in that direction, but always on the forward side of the brass. The same observation has been made in marine-engine journals, which always wear in exactly the reverse way to what they might be expected. Mr. STROUDLEY thinks this peculiarity is due to a film of lubricant being drawn in from the under side of the journal to the aft part of the brass, which effectually lubricates and prevents wear on that side; and that when the lubricant reaches the forward side of the brass, it is so attenuated down to a wedge-shape that there is insufficient lubrication, and greater wear consequently follows.

The author was engaged by Mr. W. STROUDLEY M. Inst. C. E., in carrying out his experiments on friction, and is greatly indebted to him for his kindness in placing the results at his disposal.

Large Decree for Violation of a Patent.

The Supreme Court has just awarded R. A. TILGHMAN, of Philadelphia, $320,000 damages for the infringement of his glycerine patent, deciding that an infringer who defies a patentee cannot, after legal defeat, escape by paying merely the license fees which a licensee has paid. The license fees would have amounted, without interest, to $35,000; but the court awarded nearly ten times that amount as damages on the ground that an infringer is liable to account for all the savings and benefits derived from the wrongful use of the patent. Mr. TILGHMAN was once defeated in the Supreme Court by a vote of four to three, the same vote by which the Telephone case was decided. Mr. GEORGE HARDING, of Philadelphia, the counsel representing Mr. TILGHMAN, brought a new suit and carried it again to the Supreme Court. That court then reversed its former decision by a unanimous vote, and awarded him the amount above named.

AT a late meeting of the Aqueduct Commission a resolution was passed directing the Chief Engineer to make experiments upon the resistance of brick, stone and other material to the percolation of water under high pressures. The results are to be used in considering the materials to be used in the Quaker Bridge dam, but the expenditure for the tests is limited to $500. At the same meeting, as before announced, Messrs. JOSEPH P. DAVIS, J. J. R. CROES and HERMANN SCHUSSLER were appointed a board of experts to consider and report upon the plans of the Quaker Bridge dam, as projected by the engineers of the Commission, and such modifications as have or may be presented, in plan or cross-section, and also to advise the Commission as to the proper mode of construction and best material to use in this dam.

THE strike of the switchmen on the Chicago, Burlington & Quincy is leading to grave trouble, reports of a disturbance approaching a riot being received as we go to press.

Standard Point Switch: Boston & Albany Railroad.

The accompanying plate is reproduced from the standard tracing in use by the Road Department of the Boston & Albany Railroad, for the use of which we are indebted to Mr. C. E. ALGER, of Springfield, Division Engineer.

The switches are made in the company's shops at Springfield, and the standard plan was adopted to ensure exact uniformity in the manufacture of the switch, and especially to ensure the correct placing of the switch by the trackmen.

The switch is reported to give thorough satisfaction in every way, and as the Boston & Albany has the reputation of being the best surfaced and smoothest riding road in New England this is no light testimony in its behalf. The Tracy stand is used with the switch and a bolted rigid rail frog made by the Ramapo company.

Those who are familiar with the various forms which the Lorenz switch has taken will be able to judge of the advantages of the forms and dimensions of the points, connecting rods, braces, etc., used in this switch, while the managers of roads who are still using the old fashioned stub switch may find it of interest to examine the general features of this form of turnout and see if they can discern any advantages which it has over their own device.

Two features which are especially worthy of note are the ¾ in. rod just in front of the points, holding the main track exactly to gauge, the discarding of the usual long switch ties, and the use of ordinary ties staggered as shown in their place, and the guard rail used in front of all facing switches. The last, however, are avoided on the Boston & Albany wherever possible.

The Latest Rapid Transit Project.

It is announced that the "City Railway Co. of New York" has been incorporated to build a new line between the Battery and Harlem. The plans originate with Mr. DAVID H. KING, builder of the Equitable and Mills Buildings, and many others in this city. The plans for the first section of the road are stated to be all complete and the route practically chosen. The intention now is to start at South Street opposite the lower Brooklyn ferries, and thence by a curved line, run along in the rear of the Produce Exchange, across Broadway, between Morris and Rector Streets, thence through private property west of Broadway to a point between Sixth and Seventh Avenues at their southern extremities, and continuing on in a straight line to a point near Fifty-ninth Street, where it curves west to the Boulevard. Branches are proposed to connect the main line with the Post Office and the Grand Central Depot and with the ferries on the east and west sides of the city.

The roadway will be 50 ft. wide, the foundation being of concrete, on which will be laid heavy ties to carry heavy steel rails. The grade will be about 12 ft. below the grade of the street. The streets will be crossed by a tunnel, and the road will be underground from the starting point to the terminus. Electricity is proposed as a motive power.

The buildings already on the line of the road will be torn down, and in their places four-story fireproof buildings will be put up. The basements of these buildings will contain the road. On the level with the street above, the plan contemplates a sort of interior street, 25 ft. wide, for foot passengers only. In the center will be columns which will support the floors in connection with the side-walls. On either side of the street will be booths, to be used for various purposes. This footway will be practically a covered street from one end of the city to the other, lighted by electricity.

Above the street the first floor will be so constructed as to provide for another four-track road, if necessary in the course of time, bridges being built across the intersecting streets. Above this floor will be either dwelling houses or places of business, as seems best. In the middle of the block there will be a big air shaft which will give light and air to the buildings on each side of it, and at the same time make the street light during the day. The buildings will be absolutely fire-proof. A fireproof wall will thus run from one end of the city to the other, across which a fire could not get. There will be four tracks, the two inner being for express trains, and the two outer for way trains. Stations on the inner tracks will be half a mile apart, and those on the outer track about five blocks apart. It is expected that the express trains will make thirty miles an hour, and the way trains twenty miles.

The cost of the road has been estimated at $5,168,100 a mile, which it is stated will be subscribed without difficulty, and the rental from the buildings alone, it is stated, will pay 5 per cent. on bonds at $5,000,000 a mile.

Mayor HEWITT has expressed his entire approval of the project, and his willingness that it should be built by 3 per cent. city bonds, under a 5 per cent. rental contract to revert to the city at the end of 35 years, as in his Elm Street project.

Railroad Culvert Pipe.

A neat and useful catalogue just issued by the firm of BLACKMER & POST, manufacturers of culvert and sewer pipe in St. Louis, furnishes the text for a few remarks upon the very sensible substitution of this material for wooden culverts on many of our railways. In many parts of the West wood was practically the only available material for culvert-making when the existing roads were constructed; but while the short life of wood and the dangers entailed by its decay were early recognized, it has required experience and time to bring forward an efficient substitute.

This substitute for the smaller openings is the thoroughly vitrified clay pipe; it cannot be damaged by rust, decay or atmospheric changes, and it is cheap, and can be readily laid, all of which are very necessary qualifications. An examination of the catalogue referred to shows that the proper laying of this pipe has been carefully studied to prevent the disastrous "washouts" that would result from carelessness in this respect; the lower half of the pipe is imbedded in concrete and the ends are protected by parapet walls of stone or brick. Experience has also taught this firm, at least, that economy and longitudinal stiffness demanded a longer length of pipe and deeper joints than were at first used; and in the larger sizes (from 12 to 24 in.) they now make the depth of socket equal one-sixth the diameter of the pipe, and the length is 2⅓ ft. instead of 2 ft.

The total sales in the last 10 years as given in the catalogue, for the double strength or railroad pipe, show very conclusively the rapid increase in its use by railway companies. As this table is instructive as showing the sizes of pipe most in demand it is published in full; it also shows that the output of this one firm in this class of pipe has increased from a total length of 2 miles to 100 miles in the time mentioned:

Year	12-in.	14-in.	15-in.	16-in.	18-in.	20-in.	21-in.	22-in.	24-in.	Total
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
1878	8 288		2 046		914				290	11 538
1879	19 612		10 482		1 430				640	31 564
1880	17 784		10 464		6 934		2 870		3 052	41 104
1881	21 324		20 814		11 290		2 914		5 884	62 226
1882	26 972		12 258		15 722		7 784		11 314	74 050
1883	9 304		10 748		12 112		2 062		5 776	40 002
1884	24 530		6 706		9 432		5 358		9 612	55 638
1885	17 492	1 904	7 686	3 142	9 328	1 308	526	912	16 960	60 258
1886	19 960	2 912	15 752	5 394	18 296	11 052	2 336	296	19 296	95 294
1887	21 570	913	11 008	2 904	33 358	8 073	1 774	14	22 068	109 682
Totals	187 236	5 729	107 964	11 440	118 816	20 433	26 624	1 222	101 892	5813 56

The catalogue further shows that 100,800 sq. ft. of floor area, 20 kilns of 40 tons capacity each, and all the accompaning machinery, presses, etc., here turn out about 25,000 tons annually of sewer and culvert pipe.

The Yellow River.

The *London Spectator* says that the Yellow river, from the enormous rapidity of its volume when swollen by melted snow, is the worst of offenders. Its new bed, even in 25 years, has risen far above the plain, and as the dikes grow from hillocks into hills, from mere walls into ranges of earthworks like fortress sides, hundreds of miles long, the effort overtaxes the skill of the engineers and the perseverance even of Chinese laborers. The ablest engineers in India were beaten by the Damoodah, though it is, compared with the Hoang-Ho, like a trumpery European stream, and though the labor available could hardly be exhausted. The truth of the matter is that, in all such cases, the upper sections of the dikes cost too much for complete repair, and tend to be inadequate; and when the Yellow river, gorged with water from the mountains till it forms in reality a gigantic reservoir, averaging a mile broad, from 300 to 500 miles long, and 70 ft. deep, all suspended in air by artificial supports, comes rushing down in Autumn, the slightest weakness in those supports is fatal.

On Sept. 27, the river was at its fullest, its speed was at its highest, there was probably a driving wind from the west, a bit of dike gave away, the rent spread for 1,200 yds., and—our readers remember, for CHARLES READE described it, the rush into Sheffield of the Holmfirth Reservoir. Multiply that, if you can, by 2,000, add exhaustless renewals of the water from behind—five Danubes pouring from a height for two months—and instead of a long valley with high sides which can be reached, think of a vast, open plain, flat as Salisbury Plain, but studded with 3,000 villages, all swarming as English villages never swarm; and you may gain a conception of a scene hardly rivalled since the Deluge. The torrent, it is known, in its first and grandest rush, though throwing out rivers at every moment at every incline of the land, had for its center a stream 30 miles wide and 10 ft. deep, travelling probably at 20 miles an hour—a force as irresistible as that of lava. No tree could last ten minutes, no house five; the very soil would be carried away as by a supernatural plowshare; and as for man—an ant in a broken stopcock in a London street would be more powerful than he. Swim? As well wrestle with the Holyhead express. Fly? It takes hours in such a plain to reach a hillock 3 ft. high, the water the while pouring on faster than a hunter's gallop.

There is no more escape from such a flood than there is escape from the will of God, and those Chinese who refused even to struggle were the happiest of all because the quickest dead. Over a territory of 10,000 sq. miles, or two Yorkshires at least (for the missionaries report a wider area), over thousands of villages—3,000 certainly, even if the capital is not gone, as is believed—the soft water passed, silently strangling every living thing, the cows and the sheep as well as their owners, and for ourselves, who have seen the scene only on a petty scale, we doubt whether the "best-informed European in Pekin" is not right when he calculates the destruction of life at 7,000,000.

A Well Founded Protest.

A Committee of the Architectural League presented the following protest on Thursday last, as ordered by the League at a previous meeting, to Ex-Gov. ALONZO B. CORNELL, Chairman of the Executive Committee of the Grant Monument Association. It is astonishing that the Committee in charge of such a work should have issued a circular of such character as to make necessary such a protest, but as the necessity arose we are glad that the Architectural League was equal to the occasion:

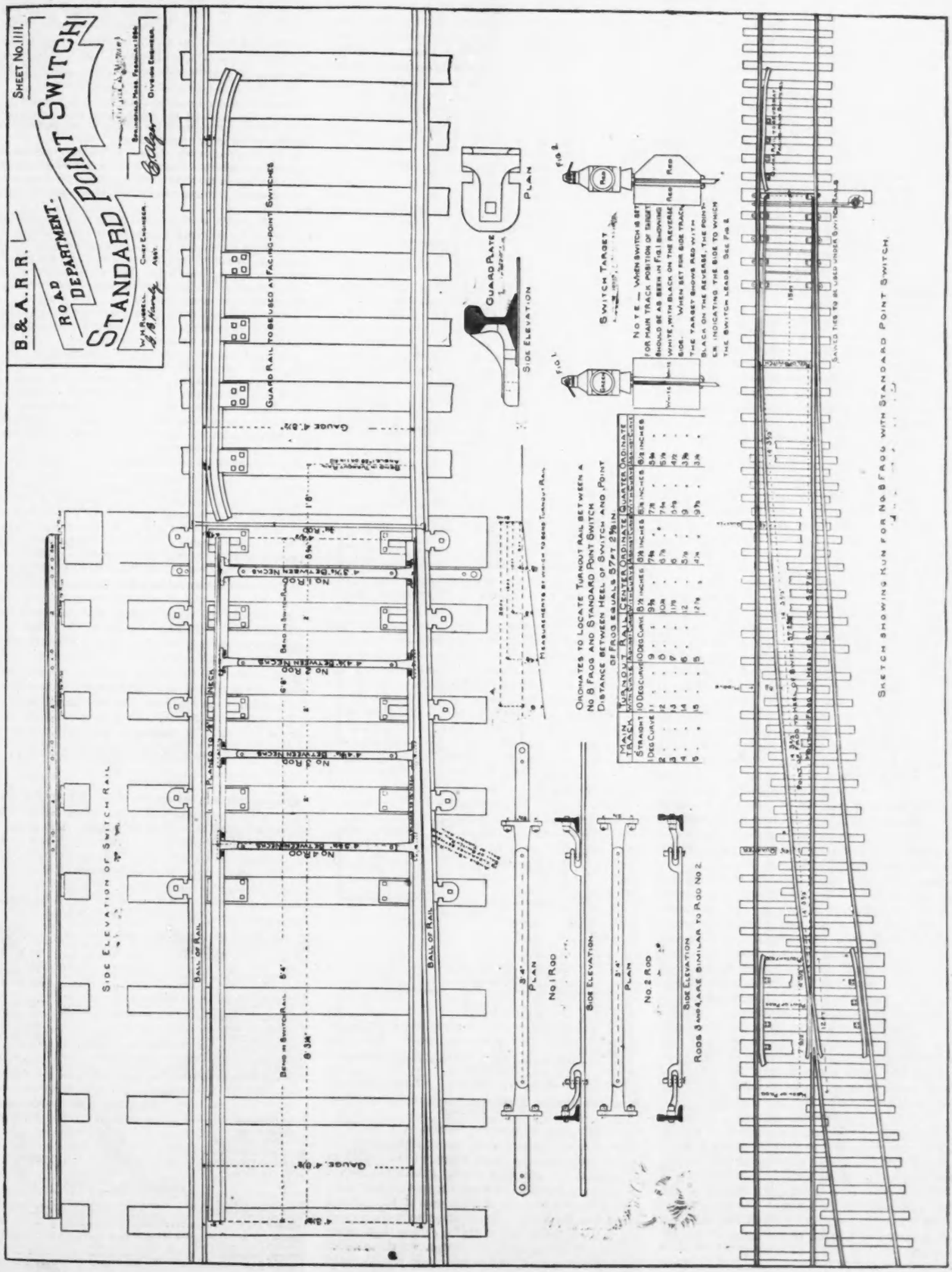
The Architectural League, of New York, herewith enters protest against the terms of your circular invitation to competitors for the Grant Monument, bearing date January 26, 1888. In its opinion many of the conditions as therein set forth are, by reason of their indefiniteness and ill-judged nature, such as will not attract designers of repute, and it would more specifically call your attention to the following sections of your circular:

1. To Section 2, in which the proposed cost of the monument is not stated with that assuredness and authority that will place competitors upon equal terms, the amount to be expended being practically left to the judgment of each.

2. To Sections 5, 6 and 8, which permit designs to be submitted at different scales—one-quarter and one-eighth inch to the foot—in different mediums—line and "washed" or brush made drawings—and in different materials—drawings or models.

To put competitors upon an equal footing there should be but one scale to which designs should be made, and but one manner in which they should be exhibited, and to this one scale and one manner all should be bound. It has been found that a scale of one-eighth or one-sixteenth inch to one foot is sufficiently large to afford opportunity for the exercise of the most critical judgment, and pure line drawings, in pen and ink, the most fair media of representation.

The precise nature and quality of sculpture should not be and is not now to be considered. Its purpose


B. & A. R. R.
ROAD DEPARTMENT.
STANDARD POINT SWITCH
SHEET No. IIII.
Chief Engineer.
Asst.
Division Engineer.
SIDE ELEVATION OF SWITCH RAIL
BALL OF RAIL
GAUGE 4'8½"
GUARD RAIL TO BE USED AT FACING-POINT SWITCHES
PLANK TO BE PLACED BETWEEN RAILS
No 1 ROD
No 2 ROD
No 3 ROD
No 4 ROD
BEND IN SWITCH RAIL
BEND IN STOCK RAIL
GUARD PLATE
PLAN
SIDE ELEVATION
SWITCH TARGET
NOTE — WHEN SWITCH IS SET FOR MAIN TRACK POSITION OF TARGET SHOULD BE AS SEEN IN FIG 1 SHOWING WHITE, WITH BLACK ON THE REVERSE SIDE. WHEN SET FOR SIDE TRACK THE TARGET SHOWS RED WITH BLACK ON THE REVERSE. THE POINTER INDICATING THE SIDE TO WHICH THE SWITCH LEADS SEE FIG 2
ORDINATES TO LOCATE TURNOUT RAIL BETWEEN A No 8 FROG AND STANDARD POINT SWITCH
DISTANCE BETWEEN HEEL OF SWITCH AND POINT OF FROG EQUALS 57FT 2½IN
MAIN TRACK
TURNOUT RAIL CENTER ORDINATE
QUARTER ORDINATE
Straight
10 Deg Curve
SIDE ELEVATION OF No 1 ROD
SIDE ELEVATION OF No 2 ROD
RODS 3 AND 4 ARE SIMILAR TO ROD No 2
SKETCH SHOWING RUN FOR No 8 FROG WITH STANDARD POINT SWITCH.

Standard Point Switch, Boston & Albany R.R.

and general intent being as well shown by drawings as by models.

3. To Section 13, which provides for the assumption by your Committee of the property right in the chosen designs upon the payment of the sums set forth.

4. To Section 17, which, in the opinion of your memorialists, is the most faulty of the provisions. To request competitors to underbid each other in the price of their services is not the way to secure the best talent.

In conclusion, the Architectural League, of New York, has entered this protest wholly and only with the desire to point out to your Committee the faults in your circular, which may render null your efforts; and to urge upon you the advisability of so amending your conditions that the best result may be reached, in the best, most expeditious and most fair manner.

In pursuance of the latter desire it presents for your consideration a copy of the Instructions to Competitors for the Indiana State Soldiers' and Sailors' Monument, which it considers a model in completeness and fairness, and which competition has been brought to a most satisfactory and successful conclusion.

The Lobnitz System of Rock Removal under Water.

We some time ago referred to the "Derocheuse," a vessel being fitted out at Renfrew, Scotland, for the removal of rock in the Suez canal. A pamphlet has just been received at this office issued by Lobnitz & Co., the builders of this rock-breaker, and the frontispiece is a very excellent photographic view of the ship afloat, chiefly remarkable for what it does not show in the shape of the actual appliances and method of breaking the rock.

From the description we find that the general dimensions of the "Derocheuse" are as follows: 180 ft. long, 40 ft. beam and 12 ft. depth of hold. The "rock-cutters" are ten in number, and take the form of heavy chisel-pointed rams, 42 ft. long, and weighing 4 tons each. Five of these rams are arranged on each side of the well through which the buckets work that lift the broken rock. The rock-cutters are raised by hydraulic power, and are allowed to drop 10 to 20 ft. on the rock; about 500 blows per hour can be delivered. The dredging machinery is very powerful, and is especially adapted to lifting broken rock. The bucket-chain is driven by a four-cylinder compound engine of 200 I. H. P., which by friction gear works two steel pitch chains passing around pitch wheels connected with the upper tumbler.

When at work the machine is moved over the surface in a series of arcs by a special winch arrangement, the vessel being pivoted on a steel mooring pile 3 ft. in diameter which goes down through the hull in the after part of the ship, and rests on the rock. There are two of these mooring piles arranged across the hull and operated by hydraulic power in such manner as to allow the boat to advance, by dropping the forward pile and hoisting the rear one. The dredger was fitted for the voyage to Suez with twin compound engines of 300 I. H. P.

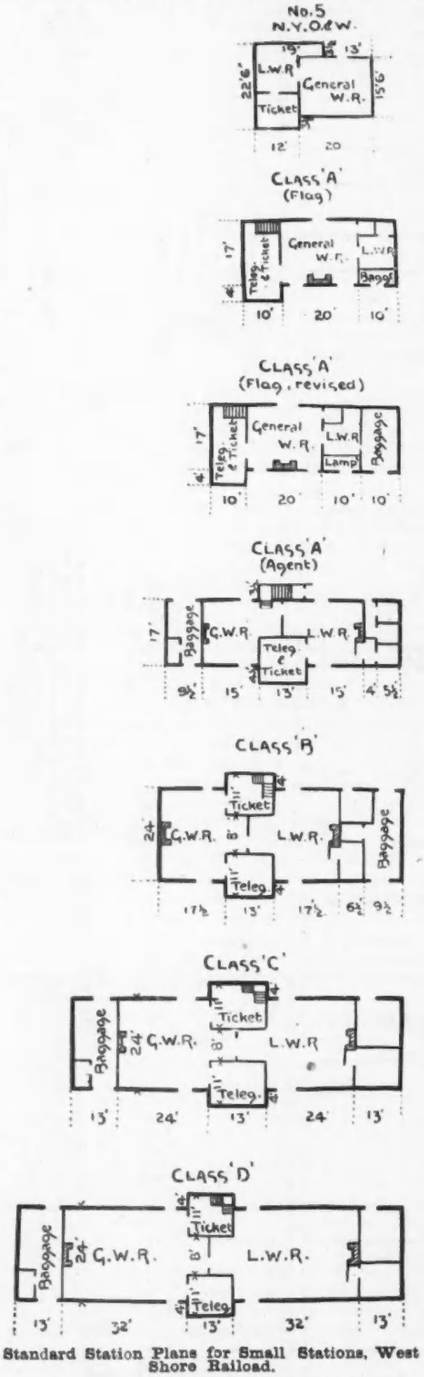
Before the boat was fully equipped extensive land trials were made with the rock-breaking rams at the Craigmillar quarries at Edinburg. The rock-cutter used weighed 2 tons and was raised by a steam winch; with 18 ft. fall. An averageof 4 cu. ft. of rock was dislodged per blow, the rock being one of the hardest in Scotland. In trials made at Greenock with the actual boat itself, under unfavorable conditions and a drop of 6 to 9 ft. instead of 20 ft. as will be used at Suez, the "Derocheuse" removed 1,660 tons of rock in 38 h. 45 m., or at the rate of 42½ tons per hour. Messrs. LOBNITZ announce that they will furnish all details and estimate of cost upon being furnished with a specimen of the rock to be dredged, depth of water, extent of work, etc. Their address is Lobnitz & Co., Renfrew, Scotland.

A recent paper on the use of electricity as a disinfectant of sewers states that the plan which is being tested in London on a large scale has already accomplished surprising results, forcing the foul gases into the air and producing a complete change in the chemical properties of the sewage. The working expense of electrical disinfection in all the immense sewerage system of London is estimated at $150,000 per annum.

BRIEF news is just received of an explosion in a coal mine, at Rich Hill, Mo., resulting in the death of 55 men.

Standard Plans for Small Stations: West Shore Railroad.

These station plans, which are now standard also for the New York Central & Hudson River Railroad, and are now given collectedly for the first time, although they were prepared some years ago, are intended to provide for the whole range of smaller stations, which are not important enough to require



Standard Station Plans for Small Stations, West Shore Railroad.

the preparation of separate designs. On the West Shore Railroad there were six or eight points at which such designs were prepared for buildings larger than are herewith given. It is in the nature of things impossible to specify a precise line of demarkation for the use of each one of the general plans, but they were each used extensively according to the probabilities of traffic rather than population. Architecturally the designs for these buildings were very neat, and so made that variety could be obtained without change in the essential details by variations in the roof lines, balconies, windows, etc.

The Charleston Jetties.

An excellent commentory upon the spasmodic, erratic, and enormously expensive policy which the Government at present pursues in its attempts to improve the rivers and harbors of the country is furnished by a memorial which has been prepared by President TUPPER of the Board of Trades of Charleston, S.C., for presentation to Congress. Some of the statements of this memorial are as follows:

That it is vitally important to the commercial interest of this city and the agricultural interests of the State that the work upon the jetties at the entrance of this harbor be speedily completed.

That in the opinion of Gen. GILLMORE, and other competent engineers, this work is not experimental or problematical in character, and that a good and permanent channel of twenty-five feet will be the result of its completion.

That the partial work already done, at an expense of $1,300,000 to the Government, demands immediate protection from deterioration and injury, which is now apparent and is caused from the need of adequate appropriations; no appropriation has been made since August, 1886, and all labor has ceased on the extension of the jetties for want of funds.

That the loss to the Government, as well as to the commerce of our port, has been material from the long and frequent discontinuance of labor.

That changes in the channel, (as predicted by Gen. GILLMORE,) have taken place, when the work should have been pushed rapidly to completion; but by neglect of the Government the work has ceased, derangements in the soundings have ensued, disasters to vessels have occurred, and the reputation of our port has suffered. For all this the General Government of our country is measurably responsible.

That our Senators and Representatives in Congress be requested to prepare a special bill asking for an appropriation of $750,000 for the improvements in Charleston harbor, as in the opinion of this Chamber the River and Harbor Bill now preparing for Congressional action may again be overloaded with unnecessary appropriations for impracticable rivers and creeks, which will occasion perhaps the veto or non-approval of the President, as was the case at the last session of Congress.

It is of course natural that the citizens of Charleston should desire Congress to attend to their wants first; but with the many other special claimants for attention they will be more apt to find that the longest way around, is after all the shortest way home, and that to join their forces with those who are asking that all the public works of the Government shall be carried on in a rational and business-like manner, is the best way to secure the completion and maintenance of their harbor improvements.

Reports of State Railroad Commissions.

MISSOURI.

The twelfth annual report of the Missouri State Railroad Commission, for the year ending Dec 31, 1886, is a cloth bound volume of 423 pages. The greater part of this is devoted to the returns received from the railroad companies, which are given very fully; and the various statistics are tabulated afterward in a form convenient for reference. The following is a condensed statement of some of the more important figures regarding the railways of the State:

Total mileage of single track main line	5,088.24
Second track	46.55
Sidings	915.80
Total cost	$246,607,041
Average cost per mile	48,450
Total of stock	127,207,480
Average per mile	27,433
Total of bonds	111,753,942
Average per mile	24,390
Total earnings	30,217,854
Total expenses	20,548,141
Net earnings	9,669,713
Net earnings per mile	1,986
Average passenger rates per mile	cts. 2.25
Average freight rate per ton mile	cts. 1.23

BRIDGES.

	Total length ft.	No. spans.
Iron trusses	33,191	215
Iron girders	7,675	185
Wooden trusses	32,082	359
Wooden girders	5,360	410
Wooden trestles	336,872	23,855
Iron trestles	5,423	334

CASUALTIES.

Employés killed	70
Passengers killed	6
Others killed	73
Employés injured	330
Passengers injured	66
Others injured	102
Total killed	149
Total injured	498

There is very little of technical matter in the report, for while the State of Missouri has done a

great deal in regulating the financial and commercial affairs of its railways, the State supervision over matters which concern the safety to life and limb of passengers and employés, which has made such progress in the East, has hardly been attempted in Missouri.

The most interesting matter in the volume relates to the control which the State has assumed over the Railway freight tariffs, which is, we believe, a greater assumption of authority over corporate business than has been attempted in any other State. By a statutory enactment all freight is divided into seven classes and the maximum rates on each are stated. Such articles as are not classified by the statute are left to the Commission to be placed in such class as they shall determine, and the Commission is authorized to reduce rates whenever in their judgment it is expedient. This act is supplemented by one which is modelled after the Inter-State commerce law. The statutes have been well drawn to secure to shippers all possible advantages in low rates for the transportation of their goods, and to prevent many abuses into which railway monopolies are liable to fall. But we cannot regard any system of State railway control as perfectly just and equitable that makes no provision for the protection of the property invested in railways themselves as well as of the property which is dependent on them.

MAINE.

The 29th annual report of the Maine Railway Commission is a pamphlet of 76 pages. The report of each road is given by itself, and the Commission reports for each the general condition of the property and the improvements which have been made or are needed. A fair sample is: "The road bed is in good condition; the track fair, the bridges are in good order." In occasional instances some general terms of disapproval are used. We fail to see how this sort of inspection and attempt at railway control can be of any particular value. No statement is made as to the character of the inspection from which the Commissioners have made up their report and we assume that they have ridden over the road, given it such an examination as their time, and their knowledge of technical matters allowed, interviewed employés and officers, and made up their conclusions. Now the public should understand that such an examination of the railroad bridges of a State is a useless farce. No lawyer, and very few civil engineers are competent to give an opinion of any value whatever, of the safety or frailty of a structure after only a hasty preliminary examination. If Railway Commissions are to interfere in the technical affairs of railway companies they should do it in such a systematic and thorough way that the results of their investigations will be respected by Railway Managers and superintendents. The Maine Commission is not the only one which is astray in this respect. Even the Massachusetts Board, which has acted so wisely in the matter of bridges, has not always refrained from meddling with matters concerning which its members were not too conversant. It is an idea which is worthy of serious consideration, whether the work of State Railway Commissions would not be increased in value if things of lesser importance were let alone, and only so many matters were taken under supervision as could be investigated thoroughly enough to secure some real benefit to the public.

No reflection is intended by this upon the conscientious manner in which the Maine Commission has evidently tried to perform its work. In fact when we consider that the total compensation which the State allows the Commissioners for their work, is the niggardly sum of $5.00 per day for time actually spent, about the pay of a skilled laborer in this city, and that this has to be collected from the railroad companies, we are surprised that the Commission has tried to do so much for the benefit of a public so thoroughly stingy, and so eminently deserving of "their money's worth and no more."

One feature of railroad control which the State of Maine has adopted, however, is worthy of commendation. If we are rightly informed, every railroad hereafter constructed in the State of Maine is required to submit a report of its surveys, and a map of its located line to the Commission, together with the reasons why the proposed road will be a benefit to the public. Opponents of the project may present their side of the case, and the Commission decides whether or no permission shall be granted for the building of the road. With the constant multiplication of schemes which threaten a wanton waste of capital in the paralleling of existing roads fully able to carry the traffic, there is increasing need, especially in the older sections of the country that the State shall assume some control over the work of railway projectors and prohibit the schemes of senseless "boomers," while fostering those enterprises which are actually to the public advantage.

A New Process for Protecting Iron from Corrosion.

The manifest reward which awaits any inventor who may be able to devise a cheap and efficient method for protecting iron from corrosion has long been a challenge to the ingenuity of chemists and metallurgists, and up to the present time comparatively little has been accomplished. The expense of tin plate limits its use to roofing and domestic utensils. Galvanizing is a cheaper process but is less durable, and its present uses are not likely to be much extended.

Paint and coal-tar are the best protections yet devised for structural iron, water mains and similar forms. The Bower-Barff process which was invented some years ago was thought to be of great promise. A scale of magnetic oxide was formed on the surface of the metal which protected it from further corrosion. This scale, however, was so easily removed that wrought iron protected by it could not be bent without injuring the coating, and any rough handling would cause the scale to crack off. The process was expensive also, and in this country at least it has never come into any extensive use.

Several years ago a corporation was formed in this city known as the Hydrogen Company of the United States, having for its object the perfection and introduction of certain inventions relative to the manufacture of heating and illuminating gas and improvements in metallurgical operations. The cardinal idea of these processes was the use of hydrogen gas. This was obtained by the familiar process of passing a current of super-heated steam over red hot iron, the oxygen being taken up by the iron and the hydrogen being set free. After this operation had continued for a short time and the surface of the iron had become oxydized, the steam flow was stopped and the iron was subjected to some reducing agent, like hydrocarbon vapor, which deoxydized it and made a repetition of the first process possible.

In the course of these experiments, carried on for the purpose of perfecting a process for the commercial production of hydrogen gas, it was noticed that the surface of the iron subjected to this treatment became so altered in its nature that pieces exposed to the weather did not rust. On further trial it was found that the surface resisted also the action of corrosive acids to a remarkable degree, and the company, realizing the enormous value of their discovery, began at once to experiment upon and perfect their process so that it could be introduced into practical use. For a long time, however, there seemed to be little prospect that the process could be made a commercial success. The character of the change was so obscure and the requirements for a satisfactory result so little known that while at one time the product of the furnace resisted perfectly the action of acids, etc., at other times, with little apparent difference in the treatment, the product would be hardly changed from its original condition. Even when the process became better understood, the degree of care and oversight required was such that the employment of cheap unskilled labor was impossible, and though successful in the laboratory there seemed to be great doubt whether it could be made equally successful in the workshop, and many of those interested in the company ceased to expect any return from the investment.

Notwithstanding this, however, some of the managers of the company persisted in their belief in the essential value of the process. They engaged the services of Dr. GEO. W. GESNER as chemist and engineer, and continued their experiments and investigations. The results of this work have been only known to those immediately interested in the company until very recently, and the description of the perfected process is now printed for the first time.

The salient features of this process from the practical point of view are that the protection to the iron consists not in the formation of a scale or film easily removed by usage, but in a change in the body of the iron itself to a certain depth so that it is unaffected by ordinary corrosive agents; this protecting layer seeming to be so thoroughly incorporated with the iron beneath that no chipping or scaling is possible. The process has also been made so simple and certain that it can be carried on by unskilled labor, and so cheaply that its cost comes far below the value of the benefit derived by the increased durability of the articles.

While the process has been proved by laboratory experiments to be applicable to all forms of cast and wrought-iron, the first product which has been commercially treated is cast-iron pipe. A factory has been erected at East Portchester, Ct., for treating iron soil pipe, with a capacity of 20 tons per day, and it was at these works that a representative of this journal made recently an examination of the process and its results.

The apparatus used consists of a furnace containing about 20 fire clay muffles, heated by a coke fire. The top of the muffle is closed securely and made air tight by a ring of asbestos packing. The pipes are placed in the muffle and soon acquire a temperature of about 1200° Fahr. They are then subjected to the action of steam superheated to a temperature equal to or greater than the temperature of the muffle for one hour; then for 20 minutes to the action of steam and naptha vapor, about a pint of naptha being sufficient for treating 100 sq. ft. of superficial area. Finally they are subjected again to the action of superheated steam alone for 20 minutes, and are then removed from the muffle. When cold the surface is little changed in appearance from that of ordinary gray cast-iron except that it has more of a bluish tinge and seems somewhat smoother. It is, of course, somewhat difficult to determine what the resistance of this surface to corrosion will be during a period of exposure to air or water of many years, but pipes which have lain outdoors ever since the recent successes in the process were attained are still untouched by rust. A test of about 10 minutes in a bath of sulphuric acid, in which an untreated piece of iron sent up a torrent of foam as it was eaten away, had no effect whatever on the pipe which had been taken from the muffle. Long immersion in strong acids eventually corrodes the surface of course; but it shows such great inertness in yielding to corrosive agents that there is every reason to believe that it will show similar gratifying results when subjected to the test of long use.

The exact chemical change which the surface of the iron undergoes has not yet been determined. Dr. GESNER, the inventor of the process, believes that hydrogen is the active beneficial agent; and following out the theory of the metallic nature of hydrogen, considers the surface formed, which he calls "a double carbide of hydrogen and iron," to be a true alloy of the hydrogen with the iron. If this is true, it is a most important fact in chemical and metallurgical science. The results of the analysis which are soon to be made are awaited with interest. We are informed that a microscopic examination of the surface shows that the surface is homogeneous with the iron beneath in the same way that a coating of tin is; that is to say there is no definite line of demarcation between the iron and the coating, but like a true alloy it blends into the metal beneath. It is this fact which renders the coating so difficult to remove and so well able to resist rough handling. Dr. GESNER, states that wrought-iron requires only 50 minutes for treatment and affirms his belief in the applicability of this process even to sheet iron, so that the new product may be a competitor of tin plates, especially for canning and roofing purposes. Plans are in preparation for a large factory in South Brooklyn, especially for the treatment of wrought-iron, and the company intends both to treat various articles for the trade and also to license manufacturess to erect furnaces in connection with their works.

At present the principal attention will be given to the iron pipe trade, and the vast field for this work in water mains and service pipes, and in soil pipes and sanitary appliances is easily appreciated. One especially interesting feature of this process is in connection with the increasing use of wrought-iron and steel for water mains. It is well known that especially for high pressures and large mains there is a great economy in first cost in the use of wrought mains instead of cast, and one great reason why engineers are slow to use them is that their greater tendency to corrosion, resulting in shorter life and

frequent accidents and repairs, confirms the belief in the final economy for permanent work of the more expensive cast-iron.

Another use of this process is in the treatment of architectural and structural iron. It has often been bewailed that the fine pearly gray of cast-iron fresh from the foundry could not be kept permanent, avoiding the necessity of frequent painting or of concealment. The color of castings treated by this process is almost identical with that of the raw iron; and, if its permanency is assured, it will in effect furnish our architects with a new material, of low price and great artistic value.

Another direction in which the process may be of great economic value, is in the protection of steam boilers. Especially in marine service where the life of a boiler is so short, and the necessity of frequent and expensive renewals so burdensome, anything which would give permanent protection from corrosion would revolutionize present practice, and be worth uncounted millions.

It is needless, however, to discuss the various great benefits which would attend the introduction of a practical process for removing from iron and steel their present want of durability. They are manifest to every one. The process which is the subject of this article is certainly of great promise, and is deserving of the attention and careful examination of every one interested in engineering and the industries to which benefit is promised.

The managers of the company ask the fullest investigation of the merits of their process, and are confident of its great practical worth. The office of the company is at 120 Broadway, Room 17, 8th Floor. Mr W. H. GRENELLE, is General Manager and Gen. HERMAN HAUPT is Consulting Engineer.

Fall of the Apple River Bridge.

We are indebted to Mr. CHARLES F. STOWELL, Bridge Engineer of the New York State Railroad Commission, for the photograph from which our accompanying engraving was prepared of the fall of this bridge, described in our issue of Feb. 25. Mr. STOWELL says in an accompanying note:

"I beg to present you herewith, with my compliments, a view of the Apple River bridge on the Chicago, St. Paul & Kansas City Railway, at Elizabeth, Ill., which succumbed to adverse circumstances on the 15th ult.

It will be remembered that this bridge had been finished but a few days, that it had had lots of inspection in mill, shop and field, that it was proportioned for pretty heavy loads (2 consolidations and 2,240 lbs. per lin. ft.) and apparently designed to meet all contingencies except the one which actually happened, a derailed car which had run 3,600 ft. before striking the bridge, and then took out three of the main posts. In passing over highway bridges you have doubtless often noticed signs, warning the traveler not to go faster than a walk, under penalty of the law. It might be well to furnish pin-connected railroad bridges with signs something like this:"

> WARNING
> DONT TOUCH THE TRUSSES
> UNDER PENALTY OF A
> WRECK.

Mr. OLAF HOFF, Consulting Engineer, of Minneapolis, Minn, writes us in regard to the same disaster as follows:

I would like to call attention to a few facts, bearing upon the moralizing by Mr. C. F. STOWELL in your issue of 19 inst. on the wrecking of the Apple River bridge. I examined the wreck right after the accident happened. The bridge was a 180-ft. span, Pratt truss, 9 panels, 28 ft. deep.

The derailment of the car which caused the accident, took place 3,600 ft. from the bridge, where the first marks in the cross-ties were noticed, and right here one of the journal boxes had broken and the bearings dropped out, the pieces being scattered on the ground. The axle belonging here gave way when the train reached the bridge; it was found broken in two, about at the center of the second panel, and about 20 ft. behind its truck. The axle was the front one in the rear truck of the forward car in the wreck (a Merchant's Dispatch car). The cross-ties in the first panel were indented deeply at the middle, which presumably had been done by the ends of the broken axle. There was no indication of any mounting of the guard rails, and these facts, together with several of minor importance, led me to the conclusion, first, that this broken axle was the direct cause of wrecking the bridge, and, second, that no rerailing guard would have helped in this case, since the conditions under which such rerailing guards can perform the duty for which they are designed, did not exist here.

The Wreck of the Apple River Bridge.

Three posts in the north truss and two in the south truss were bent, broken or twisted out of shape; one 12 in. post was bent bodily at right angles, and another 9-in. post (next to the center of the truss) was bent twice in a reversed curve, each bend nearly at right angles. The effect of the accident upon the trusses, was like that of an explosion, on a length of about three panels of the structure. I think it stands to reason that no riveted lattice girder would have withstood this shock any more than a pin connected truss, Mr. STOWELL and the case in Pennsylvania cited by him, notwithstanding. The two accidents may have been similar, but most likely they were not.

We give with pleasure the necessary space to an engraving which certainly tends to enforce Mr. STOWELL'S moral, although it appears to us that the more immediate moral is that a car which had run derailed for 3600 ft. and was still so little out that it did not strike either end post, but took out the second post beyond *on both sides*, and so collapsed the bridge, might have been enabled to go entirely over the bridge harmlessly by proper bridge guards *and* an entirely satisfactory floor. It appears to us that all the facts together, and especially Mr. HOFF'S statements, make the immediate cause of the accident tolerably clear, as follows: An axle broke first and caused the breakage of the journal box and the derailment of the car almost simultaneously. The ground was frozen and chance helped to keep the truck running tolerably straight so that both end posts were cleared, and the derailed car was in a fair way to go across the bridge all right. Until entering on the bridge there had been no place for the broken axle to catch in even when it struck the ground; but on entering the bridge these conditions were at once changed for the worse. The ties were 8 ins. apart in the clear, and the truck was hardly well on the bridge when the broken axle came down *between* two ties, was hopelessly caught therein, and caused the "explosion" effect noted, barring hopelessly the further progress of the train and compelling the car bodies to twist so as to produce the very peculiar result noted, knocking out posts *on both sides* just past the unharmed end posts.

It appears from the published statement of the Chief Engineer that the floor consisted of 8 × 9-in. ties, 12 ft. long, and spaced 8 ins. apart in the clear, a very good floor as floors go, but bad in this; that by using thinner ties the same material would have much less clear space between ties, and materially increased the chance of derailed wheels going over safely, and kept broken axles from catching in their ties. Moreover, although there was a double outside guard rail yet the inner one was 6 or 8 ins. from the rail, decreasing by so much the chance of centering the car enough to take it over the bridge in safety even if the truck was badly broken, as appears to have been the case. If the wheels were not broken, the Latimer re-railing guard would have been extremely likely, at least, to put the wheels on the rails all right, or nearly enough so to enable them to pass the bridge, excepting those on the one broken axle. Whether this be so or not the fact that the end posts were not struck at all by a derailed car which had run 3600 ft. is a striking evidence of the great field of usefulness of that device, the lamented death of whose inventor is announced in this issue.

But we agree with Mr. STOWELL that a riveted structure of the same span and strength would have been more likely to escape collapse altogether, and that it would be much better if the range of span for which riveted structures are preferred were greatly extended. Another recent disaster tending to enforce this moral was the fall of the Hondo River bridge on the Southern Pacific Railroad where a stick of timber 12 × 12 ins. × 16 ft. fell off the car and wrecked the bridge.

Notes on the Municipal Engineering of Pullman, Ill.

Unlike most villages and cities, Pullman, Ill., was *planned* from the start. The city was carefully laid out, and before the first family moved there in Jan., 1881, everything was ready for the inhabitants, including a complete drainage system. There is now a population of 10,500. The Pullman Palace Car Co. has erected brick buildings for 1740 families, while there are at least 75 frame houses.

We give below a description of some of the leading engineering features, the data for which was kindly furnished by DUANE DOTY, Supt. of the Pullman Water-Works.

The driveways of the streets are 30 ft. in width, and are macadamized by two methods. In each case, 9 ins. of slag was put down. This was covered either by 4 ins. of Joliet gravel, or by the same depth of finely broken limestone. The latter gives the best satisfaction. At each side of the driveway are gutters 2 ft. wide paved with stone, and provided with catch basins. Between the curb and the sidewalk is a plot of grass 8 ft. wide. This is set with various kinds of trees. The sidewalks are of 2-in. plank, and are also 8 ft. wide. This makes the width of the streets proper, 66 ft., while in addition each house has a lawn terrace about 20 ft. wide. The separate system of sewerage is used, each lawn and cellar being drained of surface water. From the catch basins in the streets the surface water is conveyed to main sewers of brick from three to 6 ft. in diameter, placed in alternate east and west streets, and running to Lake Calumet.

Scale of Miles
0
100
200
300
DOMINION OF CANADA
WASHINGTON T.
OREGON
IDAHO
MONTANA
WYOMING
NEVADA
Vancouver
Victoria
Seattle
Tacoma
Olympia
Portland
Astoria
Salem
Eugene
Roseburg
Ashland
Jacksonville
Grants Pass
Medford
Crescent City
Eureka
Redding
Red Bluff
Susanville
Reno
Carson City
Virginia City
Winnemucca
Humboldt
Battle Mt.
Elko
Palisade
Mineral Hill
Austin
Stillwater
Fallon
Truckee
Susan R.
Tuscarora
Camp Mountain
Rock Cr.
Shoshone
Hailey
Ketchum
Boise City
Idaho City
Silver City
Owyhee
Huntington
Baker City
La Grande
Union
Pendleton
The Dalles
Hood River
Portland
Oregon City
Albany
Corvallis
Coburg
Junction
Dayton
Walla Walla
Wallula
Lewiston
Pierce Cr.
Mosco
Moscow
Palouse
Pullman
Colfax
Spokane Falls
Rathdrum
Bellingham
Duncan
Nelson
Kamloops
Calgary
Medicine Hat
Maple Creek
Swift Current
Moose Jaw
Fort Benton
Helena
Butte City
Deer Lodge
Missoula
Drummond
Garrison
Bozeman
Livingston
Billings
Custer
Miles City
Rosebud
Laurel
Cinnabar
Cooke
Ft. McKinney
Beaver Creek
Pocatello
Eagle Rock
Soda Springs
Malad City
Preston
Logan
Brigham
Ogden
Salt Lake City
Stockton
Provo City
Coalville
Evanston
Ft. Bridger
Green River Cr.
Black Buttes
Lathan
Rawlins
Ft. Steele
Wilcox
Coopers Lake
Laramie City
Cheyenne
Lander
Ft. Fetterman
Ft. Collins
Greeley
Denver
Colorado
Utah
Arizona

ENGINEERING NEWS SERIES OF MAPS: No 8.

FAR WESTERN STATES.

Track laid during 1887. ——————

Roads in process of construction. ——————

Roads located or under survey. - - - - - - - - -

Projects of some promise. .....

Figures refer to the accompanying list. Lines having the same number belong to the same system.

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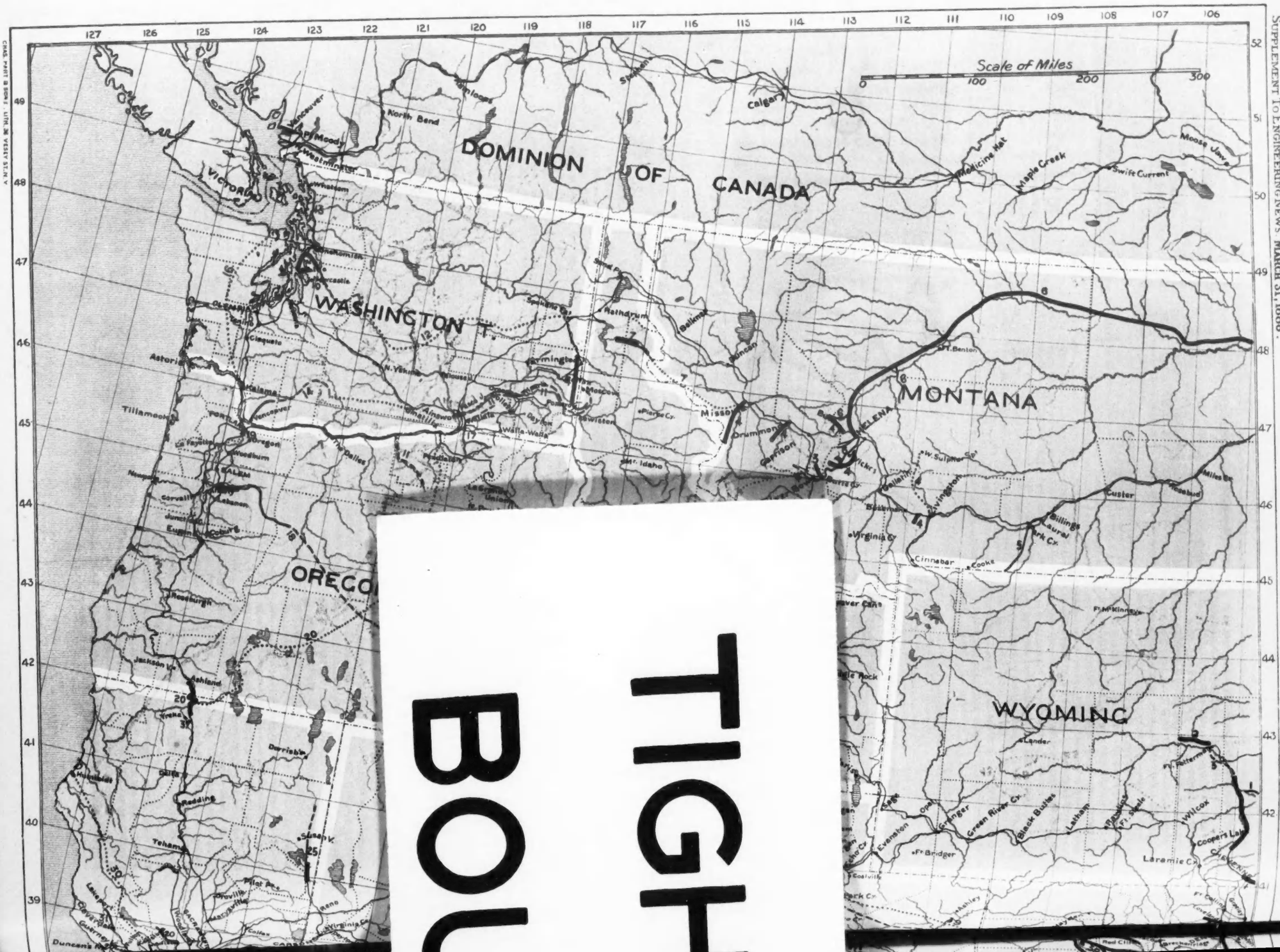
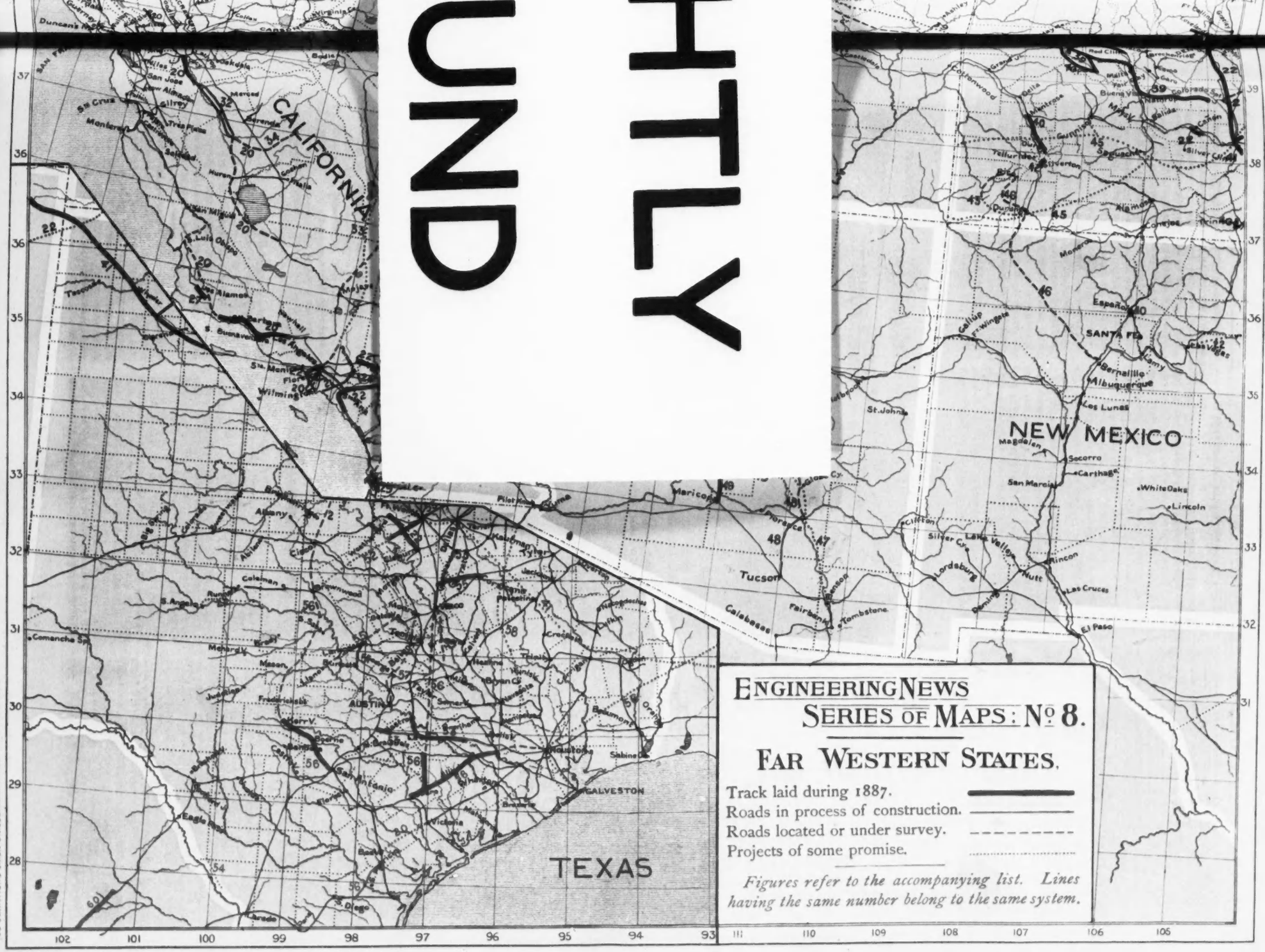

Scale of Miles
0
100
200
300
DOMINION OF CANADA
WASHINGTON T.
MONTANA
WYOMING
OREGO
Vancouver
Victoria
Seattle
Tacoma
Olympia
Spokane
Walla-Walla
Portland
Salem
Eugene
Roseburg
Ashland
Yreka
Redding
Susanville
Pilot Pk.
Lakeview
Duncan's Pk.
Astoria
Tillamook
Clatsop
Dayton
Lewiston
Moscow
Palouse
Farmington
Colfax
Pullman
Ritzville
Cheney
Ellensburg
Yakima
Wenatchee
North Bend
Kamloops
Calgary
Medicine Hat
Maple Creek
Swift Current
Moose Jaw
Helena
Butte
Missoula
Drummond
Garrison
Bozeman
Livingston
Billings
Custer
Miles City
Cinnabar
Cooke
Virginia City
Lander
Ft. Washakie
Ft. Bridger
Evanston
Green River
Rock Springs
Black Buttes
Latham
Wilcox
Laramie
Coopers Lake
Cheyenne
Ft. Collins
Greeley
Ft. Steele
Ft. McKinney
Beaver Canon
Eagle Rock
Coalville
Park City
Ogden
Logan
Pocatello
Blackfoot
Idaho Falls
Mt. Idaho
Grangeville
Orofino
Bonners Ferry
Kalispell
Flathead
Belknap
Fort Benton
Great Falls
Judith
Big Timber
Yellowstone
Gallatin
Madison
Jefferson
Deer Lodge
Bitter Root
Flathead
Kootenai
Clark's Fork
Powder River
Big Horn
Wind River
Green River
Bear River
Snake River
Columbia
Missouri
Yellowstone
Platte
Sweetwater
Laramie Co.
Coal Creek
Thayer
Stanley
Kinney
Wilson
Hanna
Carbon
Rawlins
Bridger
Fossil
Kemmerer
Diamondville
Opal
Cokeville
Montpelier
Soda Springs
Preston
Franklin
Oxford
Malad
Weiser
Payette
Boise
Nampa
Caldwell
Silver City
Owyhee
Jordan
Baker
La Grande
Union
Pendleton
Umatilla
Hood River
The Dalles
Dufur
Madras
Prineville
Bend
Klamath
Lakeview
Alturas
Susanville
Quincy
Oroville
Chico
Marysville
Sacramento
Stockton
Modesto
Merced
Fresno
Visalia
Bakersfield
Tehachapi
Mojave
Los Angeles
San Bernardino
Riverside
San Diego
Santa Barbara
San Luis Obispo
Monterey
San Jose
San Francisco
Oakland
Sausalito
Petaluma
Santa Rosa
Ukiah
Eureka
Arcata
Crescent City
Gold Bluffs
Trinidad
Humboldt Bay
Mendocino
Point Arena
Bodega Bay
Tomales Bay
Point Reyes
Farallon Is.
Santa Cruz Is.
Anacapa Is.
San Miguel Is.
Santa Rosa Is.
Santa Barbara Is.
San Nicolas Is.
Santa Catalina Is.
San Clemente Is.
Coronado Is.
Guadalupe Is.
Cedros Is.
Natividad Is.
San Benito Is.
Todos Santos Is.
Cerros Is.
Magdalena Bay
Margarita Is.
Carmen Is.
Santa Inez Is.
Angel de la Guarda Is.
Tiburon Is.
Partida Is.
Espiritu Santo Is.
Cerralvo Is.
Ceralbo Is.
Isla de la Piedra
Isla de la Roca
Isla de la Cruz
Isla de la Vela
Isla de la Vela
Isla de la Vela


CALIFORNIA
NEW MEXICO
TEXAS
SANTA FE
Albuquerque
Tucson
Tombstone
Las Cruces
El Paso
Silver City
Lordsburg
Deming
Rincon
Nutt
Socorro
Carthage
San Marcial
Lincoln
White Oaks
Los Lunes
Bernalillo
Lamy
Las Vegas
Espanola
Colfax
Taos
Questa
Red Cliff
Leadville
Buena Vista
Salida
Gunnison
Crested Butte
Telluride
Ouray
Silverton
Durango
Cortez
Dolores
Mancos
Farmington
Aztec
Bloomfield
Blanco
Pagosa Springs
Del Norte
Alamosa
Monte Vista
Saguache
Conejos
Chama
Tierra Amarilla
Espanola
Pecos
Glorieta
Las Vegas
Tucumcari
Clayton
Raton
Springer
Cimarron
Maxwell
Dawson
Trinidad
Walsenburg
La Veta
Pueblo
Colorado Springs
Manitou
Cripple Creek
Victor
Florence
Canon City
Salida
Buena Vista
Leadville
Red Cliff
Glenwood Springs
Aspen
Carbondale
Grand Junction
Delta
Montrose
Ouray
Telluride
Rico
Dolores
Mancos
Cortez
Durango
Silverton
Ignacio

The sewage is conveyed by vitrified pipes through the north and south streets, and discharges into a 300,000 gall. reservoir situated under the water tower. It reaches this reservoir at a depth of 16 ft. below the surface, and passes through a strainer with half inch meshes. The reservoir is ventilated by 8 flues which pass up the tower, and also by a 20-in. flue connecting with the chimney for the pumping boilers. The sewage is never allowed to remain in the reservoir until fermented, and with these means taken for ventilation never emits offensive odors. From the reservoir, the sewage is pumped through 20-in. pipe to a sewage farm three miles distant, where it is disposed over an area of 140 acres. It is said that one acre of land will "take" the sewage of 100 persons. By a system of under-drains the purified liquid is conveyed to Lake Calumet. Its appearance is said to be "clear and sparkling."

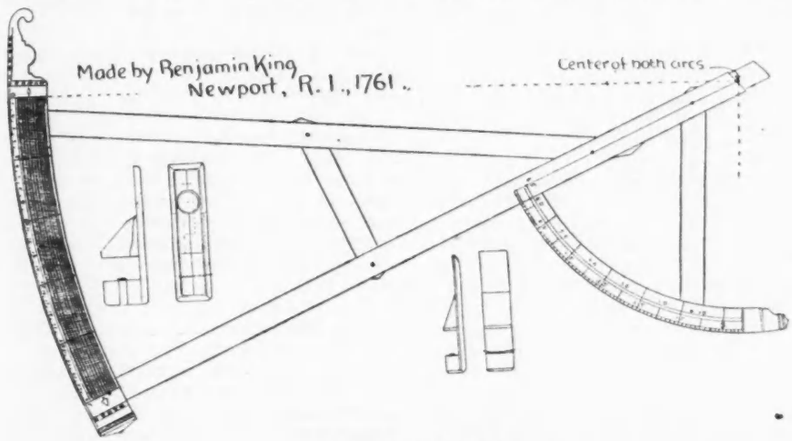
Each house in Pullman is supplied with gas, and with water. The average consumption of water is 100 galls. a day for each person. The water-works were built in 1881 by the Pullman Palace Car Co., and under the supervision of BENEZETTE WILLIAMS. The supply of water is from the Hyde-Park Water-Works, and they are paid for pumping it through six miles of mains to the Pullman system. For fire protection, Pullman pumps, with its own engine, water to a tank of 500,000 galls. capacity, placed on the top of the tower before mentioned. The height is sufficient to give a pressure of 75 lbs. The works cost $140,000, and are constantly being extended to meet the rapid growth of the city.

Comments upon the general completeness and efficiency of all the engineering features of Pullman are not needed, as it is a well known fact that every detail has been carefully studied and faithfully carried out, and all to the manifest advantage of both the founders of the city and its inhabitants. This is attested by the fact that in 1886 the mortality was but 8 per 1,000, while zymotic diseases were almost unknown. The average mortality for the United States is about three times as great.

An old Nautical Instrument.

MR. WALTER M. MERSEROLE, C. E., of Brooklyn, N. Y., sends us a sketch, as herewith reproduced, of an old nautical instrument in his possession, or so much of it as remains. The owner is anxious to obtain a description of the missing parts, sufficient to replace them.

The instrument is skillfully made of a hard fine grained wood similar to African mahogany. According to an inscription upon it, it was made by BENJAMIN KING, in Newport, R. I. in 1761, for Capt. SAMUEL ALLEN, who sailed from that port. We should be glad to hear from any of our readers who can assist our correspondent.



An Nautical Old Instrument.

THE late clearing out of Mr. DEWITT HASKINS Hudson River tunnel makes the seventh time that that ceremony has been gone through with preparatory to starting work after abandonment, within the last 15 years. Such perseverance in the face of unfavorable conditions certainly deserves reward, and it is creditable that all the works seem 1 in good condition.

Systematic Street-Naming.

The subject of a proper and systematic method of naming and numbering streets and avenues is one worthy of much more than passing consideration, and a little thought in this direction will avoid a useless and puzzling repetition of terms and a confusion the prevention of which has a commercial as well as sentimental value. In this connection Mr. S. N. STEWART, M. E., of Philadelphia, proposes a system which has merit, especially when contrasted with the careless nomenclature too often found in our large cities.

Mr. STEWART credits Minneapolis with first applying common sense to its street names. According to the system there in use the *streets* are numbered continuously, while the *avenues* crossing them start from a central point, and are named "1st. Avenue North," "1st. Avenue South," etc. The defect pointed out in this system is the use of the superfluous word *north* and *south*. Mr. STEWART suggests that they should be called *Avenues* on one side of the line of departure and *Corso*, *Rue* or *Terrace* on the other side, with the effect of avoiding confusion and shortening the name. He approves of *Corso* as the best word, though some may use the word *Boulevard*, as in Philadelphia, if considered preferable. The main point is to make a broad distinction between the terms used for the two sections of the city.

Mr. STEWART objects to the use of the terms "*A* *Street* and "*B* *Street* for the following reasons: After 5 or 6 letters it requires a calculation to ascertain how far the street is from the central avenue, and in this calculation *J* must be omitted as many people write it like an *I*; then 25 streets exhaust the alphabet and bring us to *double A Street*, etc., and finally to *triple A Street*.

When a majority of residents object to changing old names of streets, the *Corso* or other plan can be adopted 10 or 20 blocks away from the middle line; it is on the streets farthest away and least known that numbering is most needed.

In answer to the charge that numbers are not as distinctive, as names, it may be said that names are only distinctive *when but few are used*. A numbered street at once indicates and fixes the position and relative distance of the desired thoroughfare.

PUBLICATIONS RECEIVED.

Die Berechnung des Eisenbahn Oberbaues. Von Dr. H. ZIMMERMANN, Regierungsrath in Reichsamt für die Verwaltung der Reichseisenbahnen. Berlin, Von Ernst & Korn. 2 vols., 8 vo. pp. 308; 118 cuts, 12 plates and 9 table. $3.50.

This book (Calculation of Permanent Way) treats the statics of sleepers, rails and fishplates in a new and exhaustive if highly theoretical manner, founded on the undoubtedly correct principle said to be corroborated by a long series of experiments on the Alsace-Lorraine Railways—that in every point of a loaded sleeper the pressure per square inch of bearing surface of ballast is in proportion to the deflection y of that point, the ratio depending only upon the nature of the ballast applied. Taking this ratio as given by direct measurement, the determination of the actual pressure on the ballast at any point and of the strains in the rails, sleepers and fishplates is theoretically very easy, and we need hardly say that such theoretical investigations often lead to important practical conclusions. To save practical engineers the necessity for long and troublesome calculations, the author not only gives general solutions, but has computed a good many tables and designed a large number of diagrams, which latter being plotted to scale, enable the practical results of the author's formulæ as to the behavior of any kind of permanent way, or the most favorable disposition of material, to be at once determined.

In the free use of diagrams Dr. ZIMMERMANN has rendered his work unusually easy of use, and while the inveterate German habit of rolling out theory very fine indeed is conspicuous in it, yet even the most fine-spun theory when reduced to diagram form is comprehensible, and we are confident that maintenance of way men who can read German will find a perusal of the work suggestive and instructive. It is a pity that Americans do not run a little more to theory in many such apparently simple matters as the size and length of ties, form of rail section, etc. "It wad frae monie a blunder free us, and foolish notion."

GENERAL A. W. GREELEY, Chief Signal Officer of the United States, contributes to the April *Scribner's* a valuable and timely article, answering the question "Where Shall We Spend Our Summer?" He gives some pertinent advice as to the best time for taking a short vacation, and explains the conditions of climate which make some resorts preferable to others

A Manual of Steam Boilers: Their Design, Construction and Operation. For technical schools and engineers. By R. H. THURSTON, M. A., Doc. Eng., Director of Sibley College, Cornell University, New York; John Wiley & Sons, 1888, 672 pp., 183 illustrations, many tables. Price $6.00. A new volume from Dr. THURSTON is always welcomed as an occurrence of interest and importance in the technical world. In an early issue we purpose giving a full review of this book, and will defer further description of it until that time.

Handbook for Engineers, Architects and other Workers in Iron and Steel, containing tables of capacity of I-beams and channels of iron and steel as manufactured by the Pottsville Iron and Steel Co. Also design and calculation of iron and steel floors, plate girders, etc., and other information of service to workers in iron. By J. C. BLAND, M. Am. Soc. C. E.

The above from the Pottsville Iron and Steel Co., of Pottsville, Pa., is a handsomely published "Book of Shapes" of wrought iron and steel manufactured by that company. The book has 310 pages and in a compact handy form contains a vast amount of very useful information, and aside from its diagrams of shapes and tables of sizes goes very fully into the details of construction, formulæ, etc. It is in every respect a valuable work, more so from a practical standpoint than others of much greater pretensions in title.

Le Tirage des Mines par l'Electri-Electricité. Par Paul F. Chalon, Ingénieur des Arts et Manufactures. Avec 90 figures dans le texte. BOUDRY & Co., Publishers, 15 Rue Saints Peres, Paris. Size, 7 × 4½ ins., pp. 276. 1888.

We are indebted to M. CHALON, through the publishers, for the above work on the use of electricity in shot-firing in mines and tunnels, the book being a proper sequence to the previously published work of the same author on Modern Explosives. The matter is divided into three distinct parts:—(1) Theory of the Firing of Charges by Electricity; (2) The Materials and Tools; (3) The Practical Application. The first section goes at length into the sources of electricity, its potential, resistance, etc., with the general theory of firing by electricity. The second part describes the various kinds of wires used and the detonators; giving formulæ for the amount of heat necessary for inflaming the detonator under various conditions. The various detonators are shown by well made cuts and the compositions given. This portion of the work is very full and interesting. Included in it are the methods of joining the secondary and principal conductors, and a great variety of batteries for firing the charges. The third and last part relates to the proper and most efficient use of the plant before described. The book both describes and illustrates the firing of a single hole and a number of holes under various conditions of location, including the verification of extended circuits by the galvanometer and by the telephone as suggested and first applied by M. DUCRETEL in France Other forms of verification are also described. Taken altogether the book of M. CHALON is undoubtedly the most complete treatise upon this subject which has yet reached us, and must be of great value to any reader who can take it in its present shape, as a French work.

150-TON TRAVELLING CRANE.—At the Abouchoff Steel Works in St. Petersburg is a double crane capable of lifting and carrying 150 tons. It is really made up of two travelling cranes of 75-tons capacity each of which can be used together and raise the lifting ring 40 ft. above the ground. *The Engineer* of Feb. 17, gives full details of the machine.

ENGINEERING NEWS

AMERICAN RAILWAY JOURNAL

Published Weekly at Tribune Building, New York.

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D. McN. STAUFFER. A. M. WELLINGTON.

EDITORS.

GEO. H. FROST, - - - BUSINESS MANAGER.

Subscription. – UNITED STATES AND CANADA, $5.00 *per Year;* $2.50 *for Six Months;* $1.50 *for Three Months; Single Copies,* 12 *cents.* FOREIGN COUNTRIES, $6.56 *per Year, or* 3 *cents per number additional.*

Drawings and Photographs *of all new engineering works or designs, large or small, of interest from their magnitude, novelty or originality, as well as newly adopted* **Standard Plans** *for engineering structures or details, rolling stock, etc., are always desired for early publication. Also* **Brief Technical Notes** *of the cost or manner of executing work, tests of materials, machines or other new devices, and* **News of New Construction** *of all kinds.* **Letters** *for publication must be accompanied by the name or card of the writer.*

Drawings for publication *should preferably be in plain black and white, considerably larger than they are expected to appear, with letters and figures in pencil only, all lines clean and bold.*

Coming Technical Meetings.

Engineers' Club of Kansas City, Mo.—Regular meeting, April 2. Secy., Kenneth Allen, 19 Deardorff Building.

Civil Engineers Society of St. Paul, Minn.—Regular monthly meeting, April 2. Secy., Geo. L. Wilson, City Hall.

Western Society of Engineers, Chicago, Ill.—Regular meeting, Apr 1 2. Secy., L. E. Cooley, 171 La Salle St.

Engineers' Club of St. Louis, Mo.—Regular meeting, April 4. "Thickness of Water Pipes," S. B. Russell. Secy., W. H. Bryan, 709 Market St.

American Society of Civil Engineers, New York.—Regular meeting, April 4. Secy., John Bogart, 127 E. 23d St.

Engineers' Club of Philadelphia, Pa.—Regular meeting, April 7. Secy., Howard Murphy, 1122 Girard St.

Engineers' Club of Columbus, O.—Next regular meeting at the County Court House, 8 P. M., April 7. "Thacher's Calculating Instrument, and Slide Rules." Secy., Julian Griggs, 67 E. State St.

Association of North American Railroad Superintendents.—Next meeting in New York, April 9.

Civil Engineers' Club of Cleveland, O.—Regular meeting April 10. (Civil Engineering branch of the club). Secy., C. O. Arey, 31 Blackstone Building.

American Water-Works Association.—Annual meeting at Cleveland, O., Apr 1 17, 18, 19. Secy., J. H. Decker, Hannibal, Mo.

Boston Society of Civil Engineers, Boston, Mass.—Regular meeting, April 18. Secy., S. E. Tinkham, City Hall.

American Society of Mechanical Engineers.—Meeting at Nashville, Tenn., in April or May. Secy., F. R. Hutton, 280 Broadway, New York City.

Master Car Builders' Association.—Next convention at Alexandria Bay, N. Y.; commencing June 12. Secy., M. N. Forney, 45 Broadway, New York City.

American Railway Master Mechanics' Association.—Next meeting at the Thousand Islands, N. Y.; June 19. Secy., Angus Sinclair, Chicago.

Roadmasters' Association of America.—Next meeting at Washington, D. C., Sept. 11. Secy., H. W. Reed Waycross, Ga.

THE death of Mr. CHARLES LATIMER, which is more fully noted elsewhere, is an event which will cause more genuine sorrow and sympathy among men in no way related to him by blood, perhaps, than would the death of any other engineer in this country whatsoever, because the warm-hearted and whole souled nature of the man had endeared him to hundreds and thousands who felt little sympathy with his peculiar ideas as to weights and measures and some such other matters. He was a singular compound of the shrewd and long-headed man of business and the religious and technical enthusiast, but above and beyond all such peculiarities of either kind was his complete unselfishness and warm and human sympathy with "all classes and conditions of men," which made everyone his friend and wellwisher who ever met him. We doubt if he had or ever had an enemy in the world. A more entirely unselfish man, or one who cared less for worldly rewards, never filled and filled well positions of practical responsibility. It has been shrewdly remarked that selfishness in moderation is one of the most necessary economic virtues, and Mr. LATIMER himself was in a measure an illustration of this. Had he had more of it, his worldly success would have been greater, because he had in a marked degree many of the qualities which lead to such success, as notably a quick judgment of men and intuitive skill in their management, but his interest in a multitude of things which had no relation whatever to the daily work of life undoubtedly tended to impede his professional success, both by preventing that concentration of mind which is the necessary price of such success, and by creating a certain feeling of distrust which to a large extent was not justified. But engineers of this generation who have known of it, will not forget his conspicuously admirable administration of the Engineering and Track Department of the New York, Pennsylvania & Ohio Railroad for 15 years, and hence will not fail to do justice to his abilities as an engineer as well as to his lovable qualities as a man. We shall endeavor to do justice to the first next week in a more extended sketch, but Mr. LATIMER himself would have valued the last tribute far more deeply.

THE wreck of the Apple River bridge elsewhere described is notable as the first instance on record, to the best of our information and belief, in which it has been possible to trace a wreck directly to a broken *axle* catching in between widely spaced ties. The long distance the train had run, the escape of the end posts, the undoubted early breaking of an axle, the knocking out of posts *on both sides* of the bridge directly beyond the unharmed end posts;—all these point directly to one explanation of the accident and one only; that the broken axle had thumped along very comfortably over the even surface of the frozen roadbed, but took early advantage of the eight-inch gaps between ties to fasten itself between them and so necessarily cause a general smash-up.

As such, the incident furnishes a new argument against such widely spaced floors, the principal argument of course being that derailed wheels have much less chance of passing over smoothly and safely. When one considers how very trifling is the saving from such wide spacing as compared with an almost solid floor it is extraordinary that it is so generally used, and still more extraordinary that there should be many bridges and trestles with still wider spacing. A chief reason, we suspect, is that it is often carelessly assumed that the impact is directly as the clear space, whereas it is in fact more nearly as the cube of the clear space. That is to say, as between 3 in. and 9 in. spaces, the respective impacts are about as 3^3+9^3, or $\frac{1}{28}$, rather than as $\frac{3}{9}$ or $\frac{1}{3}$. They are not exactly in this ratio, but it approaches much more nearly to the truth than any other simple expression.

MR. STEWART'S suggestions in regard to street numbering, elsewhere printed, are excellent in the case of newer cities and in the extension of old cities, ut there may be valid objections, as he himself hints, to changing long established and often historical names in our older towns. Street nomenclature which preserves the names of the founders of a city, the men who were instrumental in advancing its growth, or who were its rulers in olden and troublesome times, should be kept intact. They are old enough to be familiar to every resident at least and they have a value that is beyond mere sentiment in the lessons they teach and the memories they preserve. It is true that a sharp line should be drawn in this of use personal names; and no considerations of wealth, or benefits conferred upon a city from the mere abundance of a living man's wealth, or temporary social or political prominence, should have weight in conferring a name that very usually outlasts the personality of the source. It would seem best then to leave the old names alone when well established and of use in perpetuating certain memories; but also to stop there, and in preference to meaningless names of inanimate things, or the names of living or recently dead men of passing fame use the numbering system as suggested. Numbered streets are not quite so picturesque on a private letter head or visiting card as would be some name taken from a London or Paris street directory, and some people may object; but for the useful purposes of a street name in guiding the resident as well as stranger, and for business purposes in the transmission of goods, the systematic numbering of our highways is much more sensible.

WE give considerable space this week to the first part of a summary of the results of "Recent Researches in Friction," by Mr. JOHN GOODMAN, then a Student but since advanced to Associate Member of the Institution of Civil Engineers. We republish it from the Transactions of the Institution chiefly because it is the best and clearest presentation in small compass of the modern theory of friction, and of the evidence on which it rests, that we know of; but also in part because there are certain statements and omissions to which we feel compelled to take exception, or which seem to require some modification, as we shall show more fully next week.

The modern theory of friction is still in so inchoate a form—and we may add, is so likely to always remain so, because it does not admit of reduction to simple forms or laws without sacrifice of truth—that this is no just reproach to the paper, which is admirably clear and concise. The author was well qualified to write the paper from having been himself quite extensively engaged in experimental investigations, as will appear from his paper, and that it should have been prepared by a Student for a Students' meeting better illustrates the actual character and working of that grade in the Institution than any amount of abstract description, especially as it is only one of many such papers, not all of which, however, are read at the Student's meetings.

As every engineer of over five years' practice has to completely unlearn all he was taught in his youth, or remain in ignorance of what are now known to be facts, and as many of them have not done this completely, and some, perhaps, not at all, we apprehend that many will be glad to have the exact limits of knowledge and doubt on this subject defined. With certain limitations and exceptions which we shall note next week, Mr. GOODMAN'S paper will answer admirably for this purpose.

THE West proposes to become boundless vertically as well as horizontally, according to a paragraph in our news columns, which alleges that a 28-story building, of new design, 300 ft. high, is about to be put up in Minneapolis. We do not vouch for the correctness of the allegations there made, and should imagine that Minneapolis had hardly reached that stage of metropolitan development when such structures are called for—nor St. Paul either, we hasten to add. But we cannot but deem it possible that the modest little 10 and 12 and 13-story buildings which are now beginning to dot New York so liberally, and which were considered quite sizable buildings when the world was young, may yet be far outdone. Certainly this is far more likely than that the office population of New York will ever move far above where it is to-day. "There is room

higher up" for offices as well as for the men who have their desks in them, and so far there has been an obvious and conspicuous tendency to exhaust this possibility before even making a beginning toward going "further up town," although it is far different with residences.

Great as is now the number of 8 and 10 story buildings, New York below the City Hall will hardly average five good working stories, nor can it well do so till side-walks are widened. There is therefore still chance to double the office population by continuing the construction of what are still called "high" buildings in New York, and we cannot deem it impossible that there will yet be efforts to reduce ground rents still further by the erection of much higher buildings, which must then necessarily be largely of iron or steel, and so rather engineering, than architectural structures. When land becomes worth $30,000,000 an acre, as the choicest building lots of lower New York are now, it is a pretty good evidence that something of this kind will yet be attempted, if possible, although there will hardly be 28-story buildings outside the enterprising West. When we reflect that a square mile of land at the above rate would be worth $19,200,000,000, or nearly one-half the estimated total wealth of the United States in 1880 ($43,642,000,000) it is evident that the call for high buildings is a loud one, and the *average* value of the whole of lower New York is fully $500,000,000 per square mile, its assessed valuation being $318,000,000.

FOR the benefit of our readers interested in the subject of the reorganization of our national public works, as outlined in our last issue, we would say that the publications of the Executive Board of the Council of Engineering Societies on "National Public Works" can be obtained by addressing the President, Mr. L. E. COOLEY, 17 Lasalle St., Chicago, Ill.

ACCORDING to Paris advices M. DE LESSEPS has added a sum of about $10,000,000 to the treasury of the Panama Canal Co. in the shape of new subscriptions; but he also announces, what is very generally known, that much more money is yet required to complete the canal on the new lock basis. As the French Chamber of Deputies has voted to consider the lottery scheme, however, money may come.

It certainly begins to seem a possibility that the two American continents will first be parted by a ship canal at Panama, now that the hopeless task of starting with a canal *a niveau* has been abandoned. It is the shortest cut across from ocean to ocean, the summit level is little if any higher than at Nicaragua or other points, and, more than all else, very much of the work is done and the national pride and millions of a great nation are staked upon its completion in some shape. Even if de LESSEPS should die with his task incomplete and the entire work were abandoned by its present promoters, there should be no difficulty in reorganizing on a new basis; with the wreck and past experience as an asset a new company could probably complete there a canal against any competitor. But once opened as a lock canal, we would expect to see it ever remain a lock canal, despite the present promises and supposed plans for future deepening. Nature seems to have planted a barrier in the shape of an enormous mass of treacherous and shifting earth and rock that might well defy modern engineering and financiering in its removal at any reasonable cost. Money and time would do it; but there is a limit to both in all engineering projects, commercially considered, and the ultimate cost must bear some proper proportion to the end and revenue in view. If the Culebra cut has interfered so materially with the original plan of excavating the canal, it would be well nigh impossible of execution with the canal open to traffic.

Railway Building in the Far West.

The mileage of the new railway lines completed and under way in the States and Territories of the Rocky Mountain region and Pacific coast shown upon the map which we publish with this issue of ENGINEERING NEWS is summarized in the following table:

States.	Track laid.		In process of construction.	Located and under survey.	Projects of some promise.
	1886	1887			
Wyoming	131	115	—	95	—
Montana	16	616	157	54	150
Idaho	14	40	19	47	80
Wash. Ter.	171	75	136	315	560
Oregon	43	45	161	295	400
California	274	377	598	715	546
Nevada	—	—	—	160	—
Utah	—	6	15	330	200
Colorado	43	948	39	638	865
N. Mexico	35	53	71	200	120
Arizona	82	71	70	289	275
Total	809	2346	1266	4939	3196

While the above statement shows that the total mileage of new construction for the past year in the area included in the above list was increased 1,437 miles over the new mileage for 1886, it is evident that this increase has not been due to any general development, but to the long extension of the Manitoba system to Helena, Montana, and to several long lines in Colorado, some of which, in the eastern part of the State are beyond the limits of this map (although the mileage of the whole State is shown in the table) and have already been shown on maps No. 5 and 6. The total of 948 miles of track laid in Colorado during 1887, gives the State fourth rank in the list for the whole country, its record of work done being exceeded only by Kansas, Nebraska and Texas. The lines of the Missouri Pacific to Pueblo and of the Chicago, Burlington & Quincy to Cheyenne, were built through a comparatively level country; but the lines south and west of Denver, shown upon our map, have been principally built for the development of the mining districts in the mountains and have included some of the roughest and most expensive of last season's work. Especially is this true of the long stretch of the Colorado Midland from Colorado Springs west, and of the Denver & Rio Grande's horse-shoe shaped line from Red Cliff to Aspen. Both these companies have professed their intention to build on through western Colorado and eastern Utah to Salt Lake City, and the Rio Grande has done some work on its surveys. There is little prospect, however, that anything will be done on either of these extensions before the annual meetings of the stockholders. Various rumors have been in circulation of the absorption of the Rio Grande by the Missouri Pacific and of a Santa Fé interest in the line now under survey from a point near Albuquerque to Rico, Col., and also of a probable purchase of the Denver & Rio Grande Western by the Santa Fé. But unless these various rumors prove well founded, there is little probability that the proposed Rio Grande & Pacific will be built, as it could have little local traffic, and its construction would only be justifiable if the Denver & Rio Grande should lose its present through traffic from the west over the Rio Grande Western.

The principal work in Wyoming has been the extension of the Union Pacific's Cheyenne & Northern line, which will doubtless be pushed on to Douglas in the spring. The extension of the Fremont, Elkhorn & Missouri Valley from Fort Fetterman west fell far short of the confident prophecies of newspaper railway builders, who averred that the line was bound for the Pacific, and it was only extended to the coal mines at Glen Rock, about 25 miles.

The most prominent road upon the map is the long line of the "Manitoba" in northern Montana. In one sense this line parallels the Northern Pacific; but as it runs north of it from 75 to 300 miles it can hardly be said that its construction comes under the head of injudicious paralleling, and the field is certainly large enough for both it and its older competitor. One of the centers of most active work for the past year has been in the development of the Montana mining districts, where the Northern Pacific, through the agency of several subsidiary companies, has been doing a large amount of profitable work. The agricultural possibilities of Montana, except as a great cattle and sheep range, are still problematical, but the mineral wealth of the territory already developed is of enormous value and extent, while there is little doubt that the large areas which have never yet been thoroughly prospected will be found to contain such additional mineral riches that the railroad investments which have been made will eventually yield a satisfactory return.

The desire of the inhabitants of eastern Washington Territory that the Manitoba road might be pushed west to the Pacific coast does not seem likely to be realized at present. The Seattle, Lake Shore & Eastern seems to have fair prospects of completion across the territory from Seattle to Spokane Falls, and it is possible that it may eventually be absorbed by the Manitoba. The Vancouver, Klickitat & Yakima promises if completed to give the Northern Pacific a line to Vancouver and Portland independent of the Oregon Railway & Navigation Company's line. A very important line reported as under contract along Puget sound from Seattle is said to be backed in the interest of the Canadian Pacific which proposes to retaliate for the Northern Pacific's aid and comfort to enemies of the Canadian Pacific monopoly in Manitoba by competing for the traffic from Washington Territory eastward across the continent.

The most important work in Oregon is the long stretch of the Oregon Pacific from Albany across the Cascade Mountains and east to Boise City, Idaho. This is the line which has been reported to be backed by the Chicago & Northwestern, but the numerous financial difficulties which have caused the enterprise to drag would seem to throw some doubt on this supposition. Much work has been done on the line, however, and the fact that the country through which it runs is wholly undeveloped by railroads, renders it probable that it will be completed at an early date.

The most important piece of railroad work in the Pacific States for the year was the completion of the Southern Pacific extension across the Siskiyou Mountains in northern California and southern Oregon. Until this line was opened the nearest railway communication of Washington, Oregon and Idaho with California was *via* Ogden, Utah, about 700 miles east of the coast. The completion of this new line gives the Southern Pacific road a continuous line of railway from Portland, Oregon, to New Orleans, La., a total distance of 3,241 miles. The length of the gap closed was not great, but the work was probably as heavy and difficult as on any line which has been built this season. The projected extension of the Southern Pacific system through eastern Oregon has not advanced beyond the stage of indefinite planning. The company has done little toward developing northern California of late, partly because of the fact

that there is little fear of the territory being occupied by competitors. At an early date, however, the development of the valuable timber traffic of Humboldt and Mendocino counties will amply warrant the building of several extensions in this region. The San Francisco & North Pacific is building a line in Lake county, and there are several projects for independent lines all through the northern part of the State, most of which, however, have never advanced so far even as a preliminary survey.

The principal interest in California centers in the southern part of the State where the great influx of health seekers and wealth seekers from the East has created a number of fair sized cities, where a few years ago there was nothing but a desert. The network of new lines between San Diego, San Bernardino and Santa Barbara is well shown on the map. The principal work here has been done by the Santa Fé's California Central system, but the Southern Pacific will probably build to San Diego and some other points before long, and claim a share of the traffic. The completion of the coast line of the Southern Pacific from Santa Barbara through San Luis Obispo to San Miguel will necessitate considerable heavy work, and is likely to be delayed for a considerable time. The principal work of the Southern Pacific during the past season has been in the San Joaquin Valley, where a line is to be built from Tracy south about 300 miles, paralleling the present main line at a distance of 10 to 80 miles, with cross lines at Merced, Fresno, Visalia, etc. This line has a competitor in the San Francisco & San Joaquin Valley company which has graded 50 miles or more of roadbed close beside the Southern Pacific, and proposes to build from Mojave to San Francisco. This company has been currently reported to be backed by the Santa Fé company, which is supposed to be highly desirous of a line to San Francisco to compete with the Southern Pacific. Doubtless if a line were built or nearly built by which the Santa Fé could have an independent route to the Golden Gate, the company would avail themselves of it; but it is not very probable in the present state of the money market that the company is lending its credit to back a large and expensive fight with the Southern Pacific.

Great interest has been manifested in the various projects for lines from southern California to Utah. The fact that a line between these points must traverse about 400 miles of country, which is for the most part an uninhabitable desert, must operate strongly against the investment of capital in such a line until the through business which may be secured becomes much larger than at present. Considerable work has been done on surveys, however, and it is possible that the Union Pacific, which already has a line from Salt Lake City southwest 250 miles, may find the reports of its preliminary surveys promising enough to warrant an extension to Mojave.

The work in Arizona calls for little comment, except that the prospects for the completion of one or more cross lines from the Atlantic & Pacific to the Southern Pacific seem to be good.

The work in Southern Texas is outside the limits of our map of the Southwest, and is therefore shown upon this map. The growth of the new San Antonio & Aransas Pass system is the notable feature of this section and if the company builds its projected extension to the Mississippi river, and also secures a connection with the Rock Island, it will be a still more important factor in the development of the extreme Southwest.

In comparing this map with those of the sections previously published, it is to be remembered that while its *size* is uniform with the others, the *scale* is smaller by nearly a half, and the area included is nearly equal to three of our other sectional maps combined. With these facts in mind, the enormous extent of our territory in the far West, which is still undeveloped by railway lines becomes more apparent, while the magnitude of the work which has already been done becomes more evident.

It is in the nature of things impossible that this vast region should ever be very densely occupied either by population or railways, unless a total change of climate should occur, which is hardly likely. The part of it where most activity might be expected, and which seems somewhat surprisingly backward is Oregon and Washington. Here the climate is extremely favorable, and the rainfall very heavy, so that the region is capable of supporting a dense population; but doubtless the enormously heavy timber growth, while a fortunate fact and great source of wealth, impedes the rapid growth of population which can alone justify the rapid construction of a network of railways.

A British View of American Railway Management.

Under the heading, "American Railway Managers and Monopolies," the London *Railway News* renews with some violence the charges which frequently appear on the other side against American methods of railway management, in the following words:

"It is no matter for surprise that American railroad securities should be steadily declining in favor among capitalists in this country. The demand for the better class of investments grows continually, and there is no field which offers a wider scope for the advantageous employment of capital than the railroad system of the United States. Confidence, however, in American companies and their management has had a series of shocks, from which it will take a long time to recover. Holders of bonds have been alarmed by reorganization scandals and flagrant repudiation of obligations by some of the most prosperous lines in the country, while shareholders have been taught the lesson that increased profits do not necessarily mean better dividends on their stocks. Investment and speculation are thus alike discouraged, and until some sweeping reforms are introduced in American railroad methods, the surplus capital here, and the undeveloped resources on the other side of the Atlantic, will not be brought into the close connection so desirable in all interests.

The writer then attacks the system of contracting certain departments of the traffic to separate corporations, instancing especially an American Transportation Company which is now seeking to market its bonds in England and which claims "a monopoly of refrigerator car transportation over 10,000 miles of the principal trunk line railways of the United States." A sweeping arraignment is then made of our railway managers as follows:

The scandal of "farming out" what is considered the most lucrative part of the business of a railway company never seems to be considered by any of the parties concerned. The owners of railway property, who provide all the capital for the line and its locomotive stock, are graciously permitted to conduct the business of transporting immigrants and "niggers," and to carry coals and a few other heavy articles at low tariffs. The other branches of remunerative business are handed over to some other organization, in which, however, the officials of the company are often the largest shareholders, which acts as a sucker to draw away profits from the parent undertaking. The drawing-room and sleeping cars provide enormous dividends for the one or two organizations which virtually have free use of the railways. Express companies control and handle all the high class goods, for the carriage of which really remunerative rates can be exacted. The petroleum business is merely conducted to swell the bloated revenues of the "Standard" monopoly. Live-stock pays exorbitant toll to the corporations which are permitted to maintain "yards" on the old companies' premises, while the latest project for preying on railway revenues comes now before the British public boldly claiming a "monopoly" of refrigerator car transportation business." * * * * *

The paltry capital of this latest aspirant for a loan cannot surely enable it to compete with the available resources of "10,000 miles of the principal trunk line railways of the United States." Most of the list of companies which this petty parasite boasts of infesting could raise any new capital necessary to develop *bona fide* resources, and none of them would hesitate a moment to confiscate any amount of the net revenue belonging to the shareholders—especially if the latter be foreigners—for "betterments" or other abstruse requirements, which are as invisible as the other great American institution—the "surplus" or "reserve" fund.

It may be suggested that in permitting such outside "monopolies" to fix themselves on the revenues of a railway the directors of the company make themselves responsible to its proprietors. Here, however, an unfortunate difference in the railway administrations of the two countries arises. The American director seems to be utterly irresponsible for anything short of actual embezzlement of funds. He is not a paid servant of the proprietors, and is not even their trustee. No salary is paid him—only a fee for board attendance, nominally to cover expenses. He may be removed, but while in office he is in the happy position known to law as that of a "gratuitous bailee." A consideration of this fact destroys the fond illusion that American railroad fortunes are all "saved out of salaries," but it suggests compensations not altogether unconnected with the establishment and working of "monopolies," which may account for the vast sums of money acquired by those, other than shareholders, who are connected with the working of railways in the United States.

Our English contemporary represents doubtless the opinions of many English shareholders who are continually disappointed at the small returns from their investments, but it is a pity that the average Briton cannot more clearly comprehend that such "indictments against a whole people" disprove themselves, and that *a difference of conditions* may be the reason why certain methods of doing business prevail here, on a system of 135,000 miles managed by 300 or 400 companies and extending over a whole continent, which are naturally unheard of in the "right little, tight little island," and might be great abuses if they were. That there have been abuses in the organization of sleeping car companies, refrigerator car lines, express companies, and what not is undoubted, but in the main, American stockholders are pretty well contented.

There is no such wholesale mismanagement of railway property as is represented, and the supposed corruption is chiefly imaginary. The subsidiary companies which are alleged to be such leeches upon the railway's exchequer do generally a work at a profit which the railway company, laboring under the usual disadvantages of corporate activity, could not do for itself on the enormous scale required, except at a loss. At various times several of the great American companies have tried the plan of running the express business, the parlor car business, and the telegraph business, as well as the railroad business, and last year's developments in the Baltimore & Ohio corporation were largely the result of this unwise attempt to spread over too large a field. Cases occur, of course, where transfer companies, car trust companies and similar organizations are utilized to line the pockets of the railroad corporation officials, at the expense of the stockholders whom they serve. But the rule is rather that terminal companies, express companies, parlor car companies, and all the similar organizations connected with the development of our transportation system, are organized, first, because their business is something of a specialty, requiring a special class of officers, and secondly because their business extends over several or many lines, and it is cheaper and more effective to "pool" it in a separate company. "Pool" is a word which is acquiring a bad name, but it should never be forgotten that it represents an eminently practical and expedient idea, when it is properly applied, though our English friend seems to jump to the conclusion that whatever is not customary in England must necessarily be improper or corrupt. The proportions of

the railway securities of this country which are held abroad is, after all, very small, and the world may rest assured that the American stock and bondholder, who owns nine-tenths of most roads, is quite sharp enough to protect himself from such a wholesale confiscation of his property as our contemporary is dreaming of, and in doing so he necessarily protects his foreign fellow sufferer, unless the latter be foolish enough to go headlong into enterprises which Americans will not touch at all, as has happened in several instances.

The fact is that, while the contracts are not always as favorable to the railway companies as they might be, there is a direct and large economy in handling the express business, sleeping car business, and what not, through separate and general companies which serve all alike in that specialty. The absurdity of the contrary position, when pushed to extremes, is well illustrated by a recent remark of a bright boy that we happen to know of. He wondered why the United States Government should buy all its wheat and forage of dealers when it had no end of good farming land of its own which it might cultivate and raise its own supplies, and save the middlemen's profit! No doubt it might, and so a railway company may not only build its own road and rolling stock, but roll its own rails, engrave its own tickets and stationery, run hotels, restaurants, places of amusement, cab lines, steamships, mines of coal and metal, and in fact go into any and all of the various sorts of profitable business, with which it has more or less to do. In fact all the things we have enumerated are actually carried on to a greater or less extent by railway companies. But the great difficulty which still besets railway corporations, the multiplicity of different kinds of work with which they have to do, and getting it done as cheaply as private enterprise can do it, must remain an argument against more work of this sort than is absolutely necessary to develop the resources of the railway itself. It is by division of labor that a great part of our industrial advancement has been effected, and despite all the bad contracts which may exist, our railways would not make money but lose money by cancelling them all and trying to hire men on salary to carry on the same work, each for his own company.

CORRESPONDENCE.

Curved vs. Straight Dams.

127 East 23d St., NEW York, Feb. 27, 1888.

EDITOR ENGINEERING NEWS:

I have read with great interest the articles in your editions of Feb. 4 and 25, in reference to curved as compared with straight dams.

There may have been a reason for the adoption of curved dsma among the early engineers additional to those yet accounted for. The writer saw a curved dam built in Spain many years ago, designed by G. F. BATEMAN, formerly President Inst. C. E., then Consulting Engineer to the Iberian Irrigation Co., an English association engaged in Spanish works. The description and plates of this dam will be found in the *Transactions* Inst. C. E., in a paper read by GEORGE HIGGIN (Chief Engineer of the work referred to), about the year 1871, or within a year or two either way from that date.

This dam, not so high as any of these referred to in ENGINEERING NEWS, was longer than some of these, and yet high enough to illustrate a principle that may be quite applicable to both. It was built at the head works of the Henares canal, upon a curve or curves with comparatively short radii. The abutments were well built into bluffs upon both sides of the river, the water passing through a tunnel about 2½ miles in length, starting from the dam.

The reason for the adoption of the curved form of dam is not to be sought for alone among the principles that apply to dams with a constant depth of quiet water upon the back, but rather in the cases of dams subject to surcharged floods of such magnitude upon the crest (even after the capacity of an open by-wash, spill-way, or culverts is accounted for) as to change the conditions of stability of the top course or courses.

It will be evident that in the contingency of sudden flood, the longer the top of the dam can be made, the less will be the depth of flood water upon its crest, and it will further appear that if the down stream face be vertical at the top, or nearly so; then in case of a jumping flood the pressure upon the top course or courses, may be greatly augmented both hydrostatically, and by virtue of the law of motion converted into pressure.

No dam can be considered stronger than its weakest part, for if a breach occur in the top course, then elements of uncertainty are introduced with reference to the courses below, that call for the best possible top construction.

The crest of a dam calculated to sustain a certain depth of quiet water on the back, may not, according to its top form and the forces to which the top course or courses may be subjected, have the same factor of safety during sudden floods as the next lower portions of the dam. Hence the adoption of a plan of dam that will combine a gravity section for quiet water below, with an increase of strength in the top course or courses, for the contingency of sudden floods, would seem to be grounded on good and sufficient reasons.

A consideration of the physical and climatic conditions that prevail in different parts of the world, limit the fitting comparison of dams built in one country with those of another.

To illustrate this assertion, the writer cannot do better than describe what took place in the Spanish province of Catalaña when he was assistant to Mr. J. P. ROBERTS, whose book upon irrigation is well known to those who have studied that class of work. During an exploration we had crossed an *arroyo* (the dry bed of a ravine with a wide bottom as compared to its depth*) and walked off not more than 200 ft. from the bank, when we heard a loud rumbling sound, and looking back up stream, saw a wall of water coming down rapidly bank high—we remained there until the advancing water came squarely opposite our position, when we moved off in the direction of higher ground. It is more than probable that the shock of a contingency of that kind has been in some instances foreseen and provided for by some of the early engineers, whose works, even partially ruined, the writer has often had cause to admire.

It would be difficult to conceive any class of construction with the materials then used better calculated to withstand the force of impact on the top courses of a dam than that of an arch, with the best possible abutments, and the shortest possible radius of curvature.

Not only for its inherent strength, imparted to the surface of impact, but also for its capability of lowering crest depth, by an increase of top length, the curved form of dam seems to be one not undeserving of commendation from engineers.

It may be well to formulate here what the writer remembers of the practice of engineers well versed in building and locating dams for irrigation works, of sufficient magnitude to call for a careful attention to scientific methods.

The construction of dams bears an intimate relation to the three following conditions:

1. Where the dam is situated.
2. What it is wanted for.
3. What it has got to resist.

Other things being equal, a good site for a dam is that where banks appear the soundest and indicate no recent changes of channel.

If possible the dam should be longer than the square width of its location, more especially so, if built in a contracted channel like the end of a rock cañon.

The outlet being situated at the acute corner, admits of the least change and best angles in the direction of motion. To fulfil this last condition the dam should be located askew to the axis of the valley.

It should be curved if the height is considerable and floods apprehended.

The radius of curvature should be as short as possible.

The bend of a valley is a good enough site for a dam. By the production of the convex bank below the bend to intersect the concave bank opposite, a long skew line is obtained, and the lower end of the dam becomes a training wall for the bank at a point that is better so protected on account of its being the site of an abutment.

If flood water that cannot all be discharged by use or deviation below a desirable level is apprehended, the assumed height of the dam should coincide with the assumed level of flood water, and having calculated the dam's gravity section for that contingency; conceive that portion above the crest level removed and keep the lower dimensions as found.

The curve of the dam will leave a margin for impact upon the top course or courses, and the assumption of flood depth will give the proper dimensions and something to spare, provided the down stream face of the dam is allowed a sufficient slope.

In a dam built like that of the Henares canal with a surface of masonry and a concrete heart, there is an advantage in the curved form so obvious as to require no further explanation than that already set forth in the two articles in ENGINEERING NEWS already referred to.

The constant denudation of forests may some day become a prime factor in the design of American dams, for there are not wanting instances to prove even now, that the frequency and height of floods is periodically increasing, while the time of their maximum accumulation, (due to the indiscriminate cutting referred to, and possibly other causes in addition); is diminishing year by year.

H. P. BELL.

*Our correspondent's definition is inaccurate. An *arroyo* is a small stream or water-course of any kind. ED.

The Shedd bi-lobe Meter.

In answer to the query of our correspondent, we would say that the Shedd bi-lobe meter is made by FALES & JENKS, Pawtucket, R. I. Further inquiry should be addressed to them, especially as a later letter from the firm mentioned states that the meter is the device of J. HERBERT SHEDD, M. Am. Soc. C. E., as the result of large experience and years of careful effort. A card from the company appears elsewhere in this issue.—ED. ENG. NEWS.

The Proposed Panama Locks.

ST. JOHN, N. B., March 15, 1888.

EDITOR ENGINEERING NEWS:

In your issue of March 10, you give a description of Panama canal locks in which the rapid mode of filling is claimed as new. Unless I am misinformed a similar device is used at the Sault Ste. Marie lock, built by the United States Government.

If some time you could give us a description and sketch of it, it would be acceptable to

Yours truly,

J. S. ARMSTRONG.

Durability of Iron Water Tanks.

BEAVER DAM, Wis., March 13, 1888.

EDITOR ENGINEERING NEWS:

It has been a question which has troubled my mind, and I know the minds of many engineers, how long iron water towers would last; in other words, how long before they would rust out. In 1852 and 1853 I was Assistant Engineer to JAMES O. MORSE on the Savannah Water-Works, Georgia, and put up a brick tower 55 ft. high, on which was built an iron tank, I think 30×30 ft., put up by Mr. GARRISON, now of Guild & Garrison, Williamsburg. As this was 35 years ago I wrote to the Superintendent of the Savannah Water-Works, a short time ago, asking the condition of the old tank. In reply he says—"Will state that the tower put up in 1853 and 1854 is still intact, with the exception of 12 ft. added to height, it has never had any repairs to iron or brick work, otherwise than a coat of paint once in 4 or 5 years, and now carries on top of it a triangular electric tower 100 ft. in height, and has done so

for 3 years without showing any weakness." It seems to me that this shows conclusively that, with an occasional coat of paint, a wrought-iron tank is essentially indestructible from the action of fresh water.

We are now using steel for tanks almost exclusively. Can you give any experimental data as to the relative rapidity with which steel and wrought-iron plates will corrode by action of fresh water?

The old brick tower under the tank at Savannah is a good example of what can be done with very ordinary materials. The brick used were large, very ill shaped and not very good material. But every brick was put in a tight barrel, and the barrel filled with water on the scaffold, and the brick laid direct from the barrel. The cement was well mixed dry, and none used which had been wet more than 20 minutes, and the wall perfectly filled so that there was no air in the wall. The wall was only 18 ins., thick at top, with cast-iron girders extending from the center tower to the outside wall set on the wall, without any plates under them; on these girders was the tank. When the tower was finished the mortar in the lower joints could be whittled with a knife almost like lead and, notwithstanding the great additional strains put on it, more than originally designed, I don't think there is a cracked brick in it to-day. Yours respectfully, E. G. FERRISS.

[The testimony of Mr. FERRISS will be welcomed by other engineers who have questioned the durability of wrought-iron tanks, but we have no data of corresponding value regarding mild steel used in a similar manner, and put the query to our readers generally.—ED. ENG. NEWS.]

A List of High Explosives

BROOKLYN, N. Y., March, 17, 1888.

EDITOR ENGINEERING NEWS:

Recently I had occasion to compile a list of explosives containing nitro glycerine, giving the percentage of nitro-glycerine as far as it could be ascertained, and thinking that such a list might be of interest to some of your readers I send you enclosed a copy of it. Yours, etc.,

WOLCOTT C. FOSTER,
377 Quincy St., Brooklyn.

A LIST OF EXPLOSIVES CONTAINING NITRO-GLYCERINE.

Name.	Per cent. Nitro-glycerine.
Ætna powder No. 1	65
" 2 XX	50
" 2	40
" 3 X	35
" 4 X	25
" 5	15
Ammonia powder	16 to 20
Asbestos powder	varies
Atlas powder *A*	75
B +	60
B	50
C +	45
C	40
D +	35
D	30
E +	25
E	20
Atlas powder *F* +	15
Brady's dynamite	33
Brain's powder	40
Colonia powder	40
Dualin (Dittmar's)	50
Dynamite, old No. 1 (Nobel's dynamite, Kieselguhr dynamite)	75
Old No. 2	40
Old No. 3	25
Electric powder	33
Explosive gelatine	93
Forcite, 2 grades	75, 70
Fulgurite (solid)	60
(liquid)	90
Gelatine dynamite *A*	97.5
No. 1	58
No. 2	38.8
Gelatine explosive de guerre	89.3
Gelignite	56.5
Giant powder No. 1	75
New " 1	50
" 2 extra	45
" 2	40
" 2 c	33
XXX	27
M	20
Giant powder (Nobel's) No. 2	20
Glyxoline	—
Hecla powder No. 1 XX	75
Gun Sawdust	16 to 20
" 1 X	50
" 1	40
" 2 X	35
" 2	30
" 3 X	25
" 3	20
Hercules powder No. 1 XX	75
" 1	65
" 2 *SSS*	55
" 2 *SS*	50
" 2 *S*	45
" 2	40
" 3 *S*	35
Hercules powder 3	30
4 *S*	25
4	20
Horsley's powder (Some varieties)	20
Judson Giant powder No. 2	40
Judson powder *F F F*	20
F F	15
F	10
R R P	5 to 6
Lithofracteur	52
Metalline Nitroleum	varies
Mica powder No. 1	52
" " 2	40
Miners' Powder Co's Dynamite	33
Neptune powder	32.7
Nitro Toluol	70
Norrbin & Ohlsson's powder	25 to 50
Pantopolite	—
Porifera Metroleum	varies
Rendrock	33.4
Sebastin No. 1	78
2	68
Selenitic powder	varies
Seranim	—
Vigorite (U. S.)	43.8
Virite No. 1	—
" 2	—
Vulcan powder	32.6

The "Star" Water Meter.

ELGIN, Ill., March 26, 1888.

EDITOR ENGINEERING NEWS:

We have not been able to obtain the address of the Agents or Manufacturers of the "Star" Water Meter. As we would like to have some data relating to said meter at an early date, we wish you would have the kindness to direct the enclosed letter so it will reach the parties who control said meter.

Very truly, WATER COMMISSIONERS.

[We have a letter from the above parties addressed to the Agents or Manufacturers of "Star" Water Meter, but cannot forward it as we also are ignorant of the address required. Possibly some of our readers can enlighten us.—ED. ENG. NEWS.]

The Metropolitan Development of New York.

EDITOR ENGINEERING NEWS.

NEW YORK, March 22, 1888.

The very interesting map presented with your issue of 17th inst. calls attention graphically to one of the most important questions of intercommunication between cities or parts of cities likely to be considered within the next half century. The map and accompanying figures speak so directly and forcibly that the question is at once before the people. What is to be the relation of the two cities and what the means of communication between them? It is scarcely more than 25 years since New York became so cosmopolitan as to be sought out by residents of other parts of the world as a place of permanent residence, and since the values of real estate have so increased as to make it necessary that these new comers should be almost millionaires ere they may reside in comfort on Manhattan Island. The very rapidity with which these things have come has prevented the full consideration of problems whose solution would equalize the values of real estate within equal distance of the business exchange of the world's new capital.

We have too long believed that the growth of the metropolis is necessarily linear and have taken too narrow a view in speaking of the city and county of New York as the metropolis. The healthy gravelly hills of Brooklyn, offering with their invigorating atmosphere, ease of building construction, will from now on be included in the metropolitan area and the metropolis must be regarded as a city whose growth covers nearly three quadrants of the circle, two of which are now less densely populated than the third.

The limit fixed for the maximum traffic practicable on the East River bridge is less than 10 years distant. It is questionable whether the limit of strength of the structure will not be reached before the addition proposed to increase the train facilities are all applied. However that may be, the limits on the bridge will soon be reached. The interval till then, being so short, will barely suffice to offer time in which to construct other avenues of connection between the cities. The sooner we realize that the two cities are one in destiny and growth, the sooner will we be ready to meet the question of intercommunication wisely.

In the lower portions of the cities real estate cannot be easily spared for more bridge approaches. Tunnels, two at least, one down town and one up, built so as to meet the elevated, the underground or the surface trains of both cities, seem to me the necessities of the present hour. If in connection with the underground, every day more certain in New York, such tunnels could be built and set in operation, it would be found that the growth of Brooklyn, and the unity of the two cities would be immediately and greatly benefited. Ten years will not complete them. Meantime we must improve the bridge facilities, and when the limit of the efficiency of these is reached, have something else to fall back upon

TUNNELS.

[We are by no means clear that "tunnels" are the proper mode of connecting New York and Brooklyn. On the contrary, it appears to us that bridges are both the better and the cheaper mode, taking all things into account, although there is something to be said for each.—ED. ENG. NEWS.]

The Growth of Cities.

PHILADELPHIA, Pa., March 20, 1888.

EDITOR ENGINEERING NEWS:

I have been reading carefully your articles on the Brooklyn Bridge travel and the relations of the two cities with reference to the building areas, and wish to extend my congratulations upon the able manner in which you have presented the subject.

It is not often that engineering problems, as they relate to the social and economical developments of a community, are appreciated or recognized, and unless a general interest can be enlisted and the populace be convinced that their financial position will be improved, such projects will continue to slumber.

I have heard some absurd objections to the plans of connecting Manhattan and Long Islands by a tunnel, to the effect that it might transfer the commerce of New York to Montauk and let the population of New York go over to Brooklyn, etc. It does not seem to be fully appreciated that time is an important factor in these problems, and that the territory available for homes will increase with the *square of the velocity of travel.* What our cities need greatly is increased facilities of locomotion to prevent stagnation. I need not refer to the congestion produced by the storm of last week to emphasize this statement. Fortunately it is not a normal condition, but if it were, there are doubtless some who would still be satisfied with such a condition of communication.

Very truly yours,

LEWIS M. HAUPT

ENGINEERING NEWS.

ACCORDING to the recently issued "Record of Transportation Lines of the Pennsylvania Railroad," this corporation operated on Dec. 31, 1887, a total mileage on all its lines of 7,485.12 miles. Of this total 4,191.19 miles were east of Pittsburg and Erie, and 3,293.93 miles were west of these points. The total increase in line in 1887 was 80.75 miles. Reduced to single track the record shows 12,130 miles, or an increase of 409.69 miles of single track. The Penna. R. R. Division has the most track, or 2,773.72 miles.

A PATENT has been recently granted for electric apparatus to increase the tractive power of locomotives and other self-propelled rail vehicles by increasing electrically the frictional adhesion between the driving wheels and the rails. It is claimed that the tractive power can thus be nearly doubled without increasing the weight of the locomotive, and that sleet and snow difficulties will be overcome. The invention consists of a dynamo-electric machine on the locomotive, from which a current of electricity passes through a converter and "thence through the driving wheels in succession and that portion of the rails between them, the latter completing the circuit as the wheels pass over," though how this is done we hardly understand. The current, of great volume and small motive force, causes enough heat at the point of contact, it is said, to vaporize at once any moisture on the rails, and they are therefore cleared as the motor moves.

We do not know whether this particular effort will amount to anything, but electricity has a remarkable and inexplicable effect to increase tractional adhesion, making this a field of some promise.

IN France, during 1887, only 322.4 miles of railway were built by the existing systems, the longest line being 33.5 miles. The total mileage is 19,688, of which 18,158 miles are owned by the companies and 1,530 miles by the State. Only 48½ miles of new concessions were granted. Of local lines about 215 miles were built, making a total of 1,374.5 miles; the total length of these lines now authorized is 2,276, principally on the metre gauge.

ARCHITECT L. S. BUFFINGTON, of Minneapolis, has brought forward an invention which he thinks will revolutionize the world of building; viz., a system of building known as "Buffington's Patent Iron Building Construction." By it buildings can be constructed of any desired height. They are entirely of iron, starting from a foundation like the base of a bridge pier, diminishing in size as they ascend. They are to be braced diagonally by iron lattice girders with horizontal iron beams. The covering is also to be of iron, and outside of this may be ornamental sheathing of stone, terra cotta or anything else. Mr. BUFFINGTON has subjected the plan to "practical engineers," we are assured in the usual way, and no flaws can be found. A "syndicate of capitalists" is also backing his system, and will erect in Minneapolis a building 80 ft. square by 300 ft. or twenty-eight stories high. Architect BUFFINGTON says:

"If a bridge can be built out 700 or 800 ft. into space from a pier, what is to hinder us going as high as we choose in a building? The syndicate which is backing me includes some of the best men of the city, who control plenty of capital, and as soon as a few details are settled we shall publish our plans."

"In this connection" it seems appropriate to mention that the land at the corner of Wall and Broad Sts., is worth somewhat more than $30,000,000 per acre, land just off the corner having sold at the last recorded sale, which was about two years ago, at $28,000,000 per acre. It will be seen that at these prices a landlord might welcome even twenty-eight stories to keep down his ground rent, and in a building designed for office use only, the danger of fire is not great. The highest buildings now in New York are about thirteen stories, which is about the limit of the rational use of brick and stone walls.

THE big steel gun lately cast at Pittsburg, appears to be an unquestionable success. The tests show up as follows:

	Ultimate strength lbs. per sq. in.	Elastic limit, lbs. per sq. in.	Elongation in 2 ins. p. c.	Reduction of area p. c.
Contract guarantee	80,000	40,000	7	7
Test piece from breech	92,500	50,000	10	10.37
" " " trunnion	81,420	40,700	27	45.41
" " " muzzle	82,120	45,470	18	20.27
" " " (transverse)	83,030	45,340	25	27.05

The casting appears to be absolutely perfect throughout, and its complete success seems assured. It is to be of 6-in. bore, and has just been turned over to the Government finished to 5¾ ins.

THE Panama *Star and Herald* says that the work at Mindi, on the Panama canal, was finished on Feb. 22, and the first 8 miles of the canal, from Colon to Gatun, opened to traffic by small vessels. The Mindi hill was the one difficult rock barrier at the Colon end of the canal, and various parties have been working at its removal with varying energy for 5 or 6 years past.

PERSONAL.

WM. D. WALLS has been appointed superintendent of the water-works at Dover, Del.

ALFRED HUNT, President of the Bethlehem Iron Company, died in Jacksonville, Fla., on March 28, aged 72 years.

J. W. POTHARD, a chief of party in the Nicaraguan Canal Survey, is reported as on his way home, the climate being too severe for his constitution.

Col. THOMAS MCKISSOCK, President of the Council Bluffs & St. Louis, Ry., died at St. Louis, Mo., March 22. He commenced as a chainman on the Erie road in 1846, and has been manager of a number of roads.

JOSEPH WEIS, inventor of the new electric motor, which is being tried on the Jersey City street railways, died in Jersey City, N. J., March 25.

W. G. COOLIDGE & Co., of Chicago, Ill., engineers and contractors, designers and builders of bridges, buildings and substructures, will remove their office, April 1, to rooms 609, 610, 611, Phœnix Building, 138 Jackson St., Chicago.

F. W. D. HOLBROOK, Superintendent of the Yellowstone division of the Northern Pacific R. R., has resigned. He will be succeeded by J. D. FINN, formerly roadmaster from Billings, Mont., to Forsyth, whose headquarters will be at Glendive, Mont.

GEO. W. CASS, President of the Pittsburg, Fort Wayne & Chicago Ry., died in New York, March 21, at the age of 80. He is said to have built the first iron bridge in the United States. He had been connected with a number of roads and was at one time President of the Northern Pacific R. R.

RUDOLPH HERING has been engaged as Consulting Engineer for the city of Atlanta, Ga., to supervise the preparation of plans for a sewerage system for that city. The preparation of the plans will be in the hands of the City Engineer.

SAMUEL SMITH died on March 28, aged 73 years. He started the locomotive works of SARNHINE, SMITH & Co. at Paterson, N. J., in 1848. This company was afterwards incorporated as the New Jersey Locomotive and Machine Works with Mr. SMITH as President.

ISAAC HINCKLEY, late President of the Phila. Wilmington & Baltimore R. R. Co. and its branches, died in Philadelphia on March 28. Mr. HINCKLEY was born at Hingham, Mass., Oct. 28, 1815, and was graduated from Harvard University in 1834. He was connected with New England railroads from 1846 until 1865, but in the latter year became President of the road with which he was connected at the time of his death. He was prominent in securing the control of the P. W. & B. R. R. for the Penna. R. R. in 1880.

F. M. PIERCE, well known as the former President of the Ingersoll Rock Drill Co., of this city, has purchased the interest of Mr. G. G. YOUNG in the firm of YOUNG & THOMAS, 42 Cortlandt St., N. Y., general agents for engineering supplies. Judging from the energy and skill displayed by Mr. PIERCE in connection with his old company and his wide and enviable personal reputation among engineers and men of affairs it is safe to predict an active and prosperous career for the new company.

DOMINGO GARCIA CARTAYA, late Chief of Party No. 3 on the Nicaragua Canal Survey, whose death has already been announced, was the oldest member of the party, and proved unable to stand the exposure incident to the work. Acting upon the advice of his physician he resigned his position, and was invited to headquarters by Chief Engineer-in-Charge PEARY to recuperate. Advices from Camp Carazo, of Feb. 23, say that he became gloomy and despondent, and finally attempted his own life by drowning. He was rescued, and closely watched, and seemed to have recovered. But on Feb. 14, at Greytown, he suddenly became mad, fired a pistol at Dr. BIRT and leaping out of a window broke his neck by the fall. The ball struck Dr. BIRT in the breast pocket, but a number of papers, etc., broke its force, and no fear is felt for his recovery. Mr. CARTAYA leaves a wife in New York.

SOCIETY PROCEEDINGS.

Boston Society of Civil Engineers.—The annual meeting was held at Young's Hotel, March 21. During the year 19 new members have been elected. The following officers were elected: President, DESMOND FITZGERALD; Vice President, FRED P. STEARNS; Secretary, S. E. TINKHAM; Treasurer, HENRY MANLEY; Librarian, HENRY D. WOODS; Auditor, THOMAS ASPINWALL.

The following guests of the Society were present at the dinner:

J. J. R. CROES of New York, representing the American Society of Civil Engineers; JOSEPH M. WILSON, of Philadelphia, representing the Engineers' Club of Philadelphia; J. N. LAUDER, President of the New England Railroad Club; HENRY M. HOWE, Vice-President of the American Institute of Mining Engineers; Hon. GEORGE G. CROCKER, Chairman of the Board of Railroad Commissioners; ARTHUR V. ABBOTT of the New York Superheated Water Co.; E. P. FISK, Chairman of the Committee on Drainage, of the Massachusetts Legislature; E. R. JONES, late Superintendent of the Boston Water-Works, and W. L. HOLMAN, President of the St. Louis Engineers Club.

Engineers' Club of Columbus, O.—The club met at the County Court House, March 3rd. F. B. SHELDON reported that the Committee on Constitution and By-Laws were ready to report. The proposed Constitution and By-Laws were read and subsequently adopted by a unanimous vote. Officers for the remainder of the year were elected by ballot as follows: President, JOSIAH KINNEAR; Vice-President, R. R. MARBLE; Secretary and Treasurer, JULIAN GRIGGS; Directors, C. N. BROWN and F. J. SAGER. W. H. JENNINGS then gave some interesting facts in regard to rapid pile driving done by Baird Bros. in the erection of the bridge over the Hudson river at Poughkeepsie, and in the construction of the Weehawken Docks. After discussion, C. E. FOWLER called attention to photograph and plans of Cram's Steam Pile Hammer, made in Detroit.

B. F. BOWEN then described and illustrated with blackboard diagrams his operations in driving piles in a swift current to stop a crevasse which was washed in the tow path of the canal by the Scioto river, just above the city dam at Columbus, in the winter of 1886-1887. After discussion the meeting adjourned.

JULIAN GRIGGS, *Secretary.*

Engineers' Club of St. Louis.—The club was called to order at 8.10 P. M., March 21, 1888, at Washington University. Prof. NIPHER in the chair. Mr. S. F. BURNET read a paper on "Cements and Mortar." He gave some practical hints on mixing and using same; also how specifications should read and tests be made. He exhibited specimens and gave results of tests. Some information on sand, water and lime was given. The damaging effects of freezing were shown.

The secretary read a short paper by E. L. CORTHELL in review of one by ROBERT MOORE on "Intercoeanic Ship Transfer," read before the club March 2, 1887. The criticisms of Mr. MOORE on the floating pontoon, the wheel load, comparative economy and capacity of carriage were reviewed to show the practicability of the design. Mr. MOORE replied at some length, answering the points brought up, which he claimed did not change the material aspect of the problem. Prof. JOHNSON called attention to some bars of iron which had been broken in a testing machine after having been strained beyond their elastic limit and then allowed to rest. The results were:—After a rest of one day, an increase of strength of 16 per cent. was shown; seven days, 22 per cent.; sixteen days, 26 per cent.

Mr. BRUNER called attention to a remarkable case of filtering water through an ordinary brick wall. Prof. NIPHER reported the results of some experiments on leakage of gases through brick walls.

WM. H. BRYAN, *Secretary.*

CONSTRUCTION NEWS.

RAILROADS.

[We are obliged to condense this week our current railroad news to give space for the summary of work in the far Western States.—ED. ENG. NEWS].

East of Chicago.

Existing Roads.

Philadelphia & Reading.—The Philadelphia & Reading Terminal company, which has been organized to build the proposed extension from Ninth and Green Streets to Twelfth and Market Streets in Philadelphia, is to issue $8,000,000 of 5 per cent. bonds and has acquired nearly all of the right of way for the line. The extension of the Williamstown & Delaware River line from Glassboro to Mullica Hill, N. J., is nearly completed. The Philadelphia, Gloucester & Mt. Ephraim road is to be extended during the coming summer from Mt. Ephraim to Blackwood, about 7 miles.

Pennsylvania.—A line is proposed for construction from Spencer to Bloomington, Ind., and it is reported that preliminary surveys are soon to be made. The line will run *via* Stinesville and Elletsville. The company is to abandon the operation of the Pemberton & Hightstown road on May 1, as it is impossible for the line to pay operating expenses.

Baltimore & Ohio.—The hitch in the negotiations between the Drexel—Morgan syndicate and the company has at last been settled. The syndicate takes the balance of $2,500,000 of the $7,500,000 of consolidated mortgage bonds issued by the company last August. This will, it is thought, be sufficient to tide the road over its present financial straits and with the excellent showing which the company is making under President SPENCER'S management it is sincerely hoped that the evil days of the company are over for the present.

Michigan Central.—The company is to build a short extension of the existing transfer lines at Detroit, which will complete the belt line about the city.

New Projects and Surveys.

Ossining.—Incorporated to build a line of railroad from Sing Sing, N. Y., to Whitson's Station on the New York City & Northern Railroad, about three miles. JOHN V. COCKCROFT is President, and SUMNER R. STONE Secretary and Treasurer.

Shade Creek.—This company has been chartered in Pennsylvania to build a railroad 12 miles in length in Somerset county.

SOUTHERN

Existing Roads

Louisville Southern.—A subscription of $50,000 has been voted to the eastern extension of this road by

Woodford county, Kentucky, and there is a good prospect that heavy aid will be voted by all the counties along the proposed line to Beattyville.

Norfolk & Western.—Surveys are to begin next week for a belt line at Lynchburg, Va.

Tennessee & Coosa.—This company, which has been reorganized with E. A. QUINTARD, of New York as President, has obtained a grant of right of way through Huntsville, Alabama. The line is to be pushed through from Gadsden to Guntersville at once, and it is expected that it will go on from that point through Huntsville to Jackson, Tenn.

Richmond & West Point Terminal.—A great fight is in progress over the management of this company, and three different factions are striving for its control. There seems to be little doubt the SULLY administration will be deposed, and among those prominently mentioned for the presidency is Gen. E. P. ALEXANDER of the Georgia Central system.

Georgia Pacific.—A charter has been filed for the Georgia Pacific extension company to build the extension from Columbus to Starkeville, Miss.

New Projects and Surveys.

Roanoke & Southern.—At the recent meeting of the directors at Danville, Va., it was voted to place another corps of engineers in the field under direction of C. W. PIERSON. Work is to begin on the grading about April 15, when 200 convicts from the State Penitentiary will be set at work near Martinsville. One hundred convicts will also be secured from North Carolina to work on the line in that State.

Pineville & Big Sandy.—A company has been organized by P. B. REED, JAS. G. GIVENS and others of Louisville, Ky., to build a railroad from Pineville, Ky., to the State line near the breaks of the Big Sandy, and also from Pineville through Pine Gap to the Tennessee State line.

THE NORTHWEST.

Existing Roads.

Manitoba.—It is expected that Premier GREENWAY will announce the result of his recent mission to Ottawa, at the meeting of the legislature at Winnipeg, on April 12. While at Ottawa, the Manitoba delegates were in consultation with General Manager HICKSON and other officials of the Grand Trunk with regard to the prospects of an extension of that system to Manitoba. The interview is said to have been satisfactory to the delegates. It seems probable that the Red River Valley line will be pushed to completion as soon as spring opens. It is given out that the final basis of settlement with the Canadian Pacific for the surrender of their monopoly will be the return of 7,000,000 acres of their land grant in the Northwest to the Government for which they will receive $1.50 per acre.

Chicago, Milwaukee & St. Paul.—An extension is under consideration from Mather, Wis., to Black River Falls, about 16 miles. A charter has been filed for the extension to the Gogebic mining region. Rumors are in circulation that a branch is to be surveyed from Prairie du Sac, Wis., north to Kilburne, about 25 miles.

Illinois Central.—The annual report of the company shows an increase in net earnings over 1886 of $180,487. The company has filed articles of consolidation of the Freeport, Dodgeville & Northwestern with the Chicago, Madison & Northern and also amendments to the Cherokee & Dakota charter fixing the capital stock at $5,000,000. The new bridge at Cairo is to be completed by Dec. 31, and the total cost is set at $2,500,000.

New Projects and Surveys.

Minnesota & Iowa Improvement Company.—Incorporated in Minnesota "for the construction, maintenance and operation of railroads and other works of internal improvement." The incorporators are JOHN WATSON, G. P. CROSS, H. S. NETTLETON, C. H. SMITH and D. D. BROOKS, of Minneapolis.

Chicago & Western Illinois.—This company has been chartered in Illinois to build a railroad from Sycamore to Keithsburg and from Byron to Streator. ROBERT D. MCFADDEN of Chicago, and CHAS. W. BUNN of St. Paul are among the incorporators. The scheme is in the interest of the Chicago, St. Paul & Kansas City.

Aberdeen & Sioux Falls.—Organized to secure right of way for a railroad between the points named, by C. A. BLISS, H. M. MARPLE, C. A. JEWETT and others, of Aberdeen, Dak.

Duluth, Huron & Denver.—It is rumored that the Northern Pacific company have offered to take this foundered enterprise off the hands of its original promoters, pay the $210,000 of debts which the company owes, at 65 cents on the dollar, and complete the portion of the line already graded.

THE SOUTHWEST.

Existing Roads.

Missouri Pacific. The interest in financial circles all over the country has centered this week on the stocks of the Gould lines in the Southwest. The annual meeting of the directors of the Missouri Pacific, which was several times postponed to await GOULD'S return, finally voted to declare a dividend for the quarter of 1¼ per cent. All sorts of rumors in reference to the situation of the properties are in circulation and the stock which a year ago was strong at 110, has been bobbing up and down between 70 and 80. The movement for an organization of the stockholders and bondholders of the Missouri, Kansas & Texas opposed to the present management has taken definite shape, and a new board of directors will probably be chosen at the annual meeting on May 15. The Missouri, Kansas & Texas is leased to the Missouri Pacific, which has controlled the line by the ownership of a majority of stock. The bonds, however, are principally held in Holland and it is largely to defeat a supposed attempt to run the road into bankruptcy that the present movement has been undertaken.

Atchison, Topeka & Santa Fé.—The report of earnings for December shows a net decrease of $77,312. For the year 1887, the net increase over the earnings for 1886 was $740,719.

New Projects and Surveys.

White & Black River Valley.

Office of Batesville & Brinkley R. R.
LITTLE ROCK, Ark., March 24, 1888.

EDITOR ENGINEERING NEWS:

The White & Black River Valley Railroad is now under a locating survey from Jacksonport up the west side of Black river *via* Powhatan, Black Rock and Pocahontas to the Missouri State line, 75 miles. The work is mostly light, easy grades and little rock work. The line is in the interest of the Batesville & Brinkley R. R. Contracts will probably be let for construction about the latter part of April or May. R. M. MARTIN, of Little Rock, is President, and E. G. HARRIS, of Little Rock, is Chief Engineer.

WM. J. THOMPSON, *General Manager.*

Chicago, Kansas & Arkansas.—

ST. JOSEPH, Mo., March 20, 1888.

EDITOR ENGINEERING NEWS:

I enclose map of our lines. The railroad strikes have had a tendency to knock things topsy turvy, and we will not get to work in April as had been expected. Work will begin very shortly, however, and the main line will be shoved through as fast as practicable.

WALTER G. SEAVER, *Secretary.*

The map sent by Mr. Seaver shows lines marked as under survey from St. Joseph to Ft. Smith, Ark., and on south, with branches to Springfield, Mo., and Arkansas City, Kan.; while lines are projected to Memphis, Tenn. and from Arkansas City, south across Indian Territory. In a former letter dated Dec. 25, Mr. SEAVER stated that the company has "ample means and will build from 600 to 1,000 miles this year."

Wichita, Richfield & Trinidad.—

RICHFIELD, Kan., March 23, 1888.

EDITOR ENGINEERING NEWS:

I send you map to-day of southwestern Kansas. How do you like blizzards? We still live and are going to make things BOOM this year. If there is anything we can do for you will be glad to do it.

C. H. ANDERSON, *Asst. to Pres. W. R. & T. R. R. Co.*

Kansas City, Monett & Southern.—Incorporated in Kansas to build a railroad from Kansas City, Kan., south about 250 miles. LOGAN H. ROOT, of Little Rock, Ark., POWELL CLAYTON, of Eureka Springs, Ark., STEPHEN B. ELKINS, of New York City, B. F. HOBART, of St. Louis, and others, are the incorporators.

ROCKY MOUNTAIN & PACIFIC.

Existing Roads.

Northern Pacific.—Since our list was in type, a report is received that a line is under survey from a point near Butte, Montana, to Gallatin, through the Lowland Pass. This will considerably shorten the distance from Butte and the mining camps in that vicinity to the East.

Atchison, Topeka & Santa Fé.—Vice President, C. W. SMITH, characterizes as "gossip" the reports that the company is building a line from Mojave to San Francisco and that it has purchased land near Oakland for terminals.

Southern Pacific.—A report from Montague, Cal. outlines a rather vague project for a line from that point, east through Modoc county, Cal., and through Nevada and Idaho to Kelton, Utah. It seems hardly probably that the company will build a line at present through a country as barren and uninhabited as that along this proposed route. A project is under consideration for an extension of the West Berkeley Branch Railroad from its terminus at Berryman to a point several miles distant near San Pablo. Grading and tracklaying will soon begin on the double tracking of the line to Port Costa. The company are considering the proposed Humboldt county extensions, but have not decided what route will be chosen.

New Projects and Surveys.

Messila Valley, White Oaks & Eastern.—The subscription to this project at El Paso, Tex., has reached $72,000. The company has asked a subscription of $100,000 and promises to begin work on the line at once if it is secured.

San Bernardino Central.—This company has been organized to build a road from San Bernardino, Cal., to South Riverside, about 30 miles. JOHN C. MONTEITH of San Diego, N. S. HALE of Colton and others are interested.

Statistics of Railway Construction.

ROCKY MOUNTAIN and PACIFIC STATES.

Accompanying Map No. 8 of the Progress and Prospects of Construction.

In the following list, "Track laid" is during the calendar year 1887, "Projected," as in former lists, includes only those lines not yet located, which from all the information sent us seem to have fair probability of construction. Other terms explain themselves. For officers of old roads on the following list, reference should be made to Poor's Directory or the Official List. The *numbers* given to each road correspond to those upon the map, and lines of the same system are given the same number. Otherwise numbers are arranged in order, to facilitate reference from the map to the list.

Our thanks are extended to the officers of the roads and other correspondents who have furnished us information from which the map and list has been prepared. Notice of any errors on either the map or list and further information of the progress of enterprises under way is especially requested.

WYOMING.

Existing Roads.

1. *Chicago, Burlington & Quincy.*—Track laid, Colorado State line to Cheyenne, 12 miles. Located—Burlington & Missouri River R. R., Nebraska State line to Laramie City, 25 miles.

2. *Fremont, Elkhorn & Missouri Valley.*—Track laid—Wyoming Central Ry., Douglas to Glen Rock, 28.9 miles.

3. *Union Pacific.*—Track laid—Cheyenne & Northern R. R., from 50.7 miles beyond Cheyenne to Cottonwood, 74.3 miles. Under survey, Cottonwood to Douglas, 70 miles.

Total.—Track laid, 115 miles. Under survey, 95 miles.

MONTANA.

Existing Roads.

4. *Northern Pacific.*—Track laid, Coal Spur to Cokedale, 36 miles; Jefferson Jc. to Calvin, 30 miles; Clough Jc. to Marysville, 12.5 miles; Drummond to Philipsburgh, 28.5 miles; Missoula to end of track, 40 miles. Projected, Livingston to White Sulphur Springs, 60 miles.

5. *Rocky Fork & Cooke City.*—Under construction, Laurel to Coal mines, 46 miles. President, H. S. Davis, Secretary, J. B. Hubbell, St. Paul, Minn.

6. *St. Paul, Minneapolis & Manitoba.*—Track laid, Dakota State line to Great Falls, 400 miles.——Montana Central R. R., Great Falls to Helena, 98.3 miles. Under construction Jan. 1, (track now laid) Great Falls to Sand Coulee, 16 miles. Now in process of construction, Marysville Jc. to Marysville, 7 miles; Helena to Red Mountain, 15 miles; Helena to Butte, 73 miles. Surveyed, Boulder, to Elkhorn, 20 miles; Butte to Anaconda, 25 miles; Cataract creek Branch 4 miles; Basin creek Branch 6 miles.

3. *Union Pacific.*—Track laid—Montana Ry., Anaconda mine to Walkerville, 2.82 miles; Walkerville to High Ore mine, 1.36 miles; Spurs to Higgins mines, 1.66 miles.

Total.—Track laid, 616 miles. In progress of construction, 157 miles. Under survey, 55 miles. Projected, 150 miles.

IDAHO.

Existing Roads.

7. *Cœur d'Alene Ry. & Navigation Co.*—Track laid, Wardner Jc. to Burke, 19.5 miles. Under construction, Wallace to Mullan, 10 miles. Under survey, Wallace to Granite and to Sunset Peak, 12 miles. Projected, Mullan to Missoula, Mont., 90 miles. General offices at Cœur d'Alene, Idaho.

8. *Gilman & Gold Belt.*—Graded, between Hailey and Gilman, 2 miles. President and General Manager, Jno. Gilman, Worcester, Mass.

9. *Idaho Central.*—Track laid, Nampa to Boise City, 20 miles. Projected, Boise City to Atlanta, 55 miles. General Manager, J. F. Curtis, Boise City, Idaho.

Total.—Track laid, 40 miles. In process of construction, 19 miles. Under survey, 47 miles. Projected, 80 miles.

WASHINGTON TERRITORY.

Existing Roads.

10. *Columbia & Puget Sound.*—Projected to Snoqualmie Pass, 40 miles.

4. *Northern Pacific.*—Track laid, Spokane & Palouse R. R., Belmont to near Colton, 47 miles. Under construction, near Colton to Genessee, Idaho, 14 miles.

11. *Oregon Ry. & Navigation Co.* (Operated by Union Pacific.)—Surveyed, Riparia to Moscow, Idaho, 125 miles; Wallula to Grange City, 55 miles; Wallula to Estes, 40 miles.

12. *Seattle, Lake Shore & Eastern.*—Track laid Seattle to Kelsey's Landing, 28 miles. Under construction, Kelsey's Landing to Snoqualmie Falls, 26 miles. Under survey, Snoqualmie Falls to summit Snoqualmie Pass, 50 miles. Projected, Snoqualmie Pass to Spokane Falls, 175 miles. Chief Engineer, F. H. Whitworth, Seattle, W. T.

13. *Seattle & West Coast.*—Under contract, Snohomish City to International boundary, 80 miles. President, Henry Crawford, Jr., Seattle, W. T.

14. ***Vancouver, Klickitat & Yakima.***—Under construction, Vancouver to Lewisville, 23 miles. Located, through Klickitat Pass, 80 miles. Projected, to a Junction with Northern Pacific Ry., 100 miles. President, S. W. Brown, Vancouver, W. T. Chief Engineer, R. A. Habersham, Vancouver, W. T.

New Projects and Surveys.

15. ***Olympia & Chehalis.***—Projected, Olympia to Chehalis, 70 miles. Chief Engineer, F. W. Brown Olympia, W. T.

16. ***Port Townsend & Southern.***—Projected, Port Townsend to Kalama, 175 miles. Address N. D. Hill Port Townsend, W. T.

Total.—Track laid, 75 miles. In process of construction, 136 miles. Under survey, 315 miles. Projected, 516 miles.

OREGON.

Existing Roads.

17. ***Oregon & Washington Territory.***—Under construction, Pendleton to Wallula and branch to Centerville, 50 miles.

18. ***Oregon Pacific.***—Track laid, Albany, east, about 20 miles. Under construction, end of track, east, 75 miles; on division in Eastern Oregon, 30 miles. Located, between Albany and Boise City, Idaho, 275 miles.

11. ***Oregon Ry. & Navigation Co.***—Surveyed, from mouth of Willow creek to Heppner, 45 miles.

19. ***Portland & Willamette Valley.***—Under construction, Elk Rock to Portland, 5.8 miles.

20. ***Southern Pacific.***—Projected—East Oregon R. R., through Eastern Oregon, 400 miles.

Total.—Track laid, 45 miles. In process of construction, 161 miles. Under survey, 295 miles. Projected, 400 miles.

CALIFORNIA.

Existing Roads.

21. ***Anaheim, Olinda & Pomona.***—Under construction, Long Beach to Pomona, 26 miles. General offices at Anaheim, Cal.

22. ***Atchison, Topeka & Santa Fé.***—Track laid—California Central R. R., Santa Anita to San Bernardino, 45 miles; Arlington to Santa Ana, 33 miles; Santa Ana to San Juan, 25 miles; Oceanside to Escondido, 22 miles; Los Angeles to La Ballona, 18 miles. Under construction—California Central R. R., Perris to San Jacinto, 20 miles; Los Angeles to Santa Ana; 33 miles. San Juan to Escondido, 30 miles. Under contract—Los Angeles, Long Beach & Ocean Ry., Los Angeles to Long Beach, 24 miles.

23. ***Carson & Colorado.***—Preliminary survey made, Keeler to Mojave, 110 miles.

24. ***Chino Valley Narrow Gauge.***—Under construction, Chino to Ontario, 15 miles.

25. ***Nevada & California.***—Track laid, Chat P. O. to Camp Ham, 8 miles. Under construction, Camp Ham, north, 47 miles. Under survey, end of grade to Madelain Plain, 30 miles.

26. ***Oakland, Alemeda & Laundry Farm.***—Under construction, near Oakland, 5 miles. General Manager, H. E. Drew, Oakland, Cal.

27. ***Pacific Coast.***—Track laid, Los Alamos to Las Olivas, 14 miles.

28. ***Palmdale.***—Under contract, Seven Palms to Palmdale, 6.25 miles. President, H. C. Campbell, Saucelito, Cal. Chief Engineer, W. F. Miller, Saucelito, Cal.

29. ***San Diego, National City & Otay.***—Track laid, San Diego to Oneonta, 16.45 miles, National City to Sweetwater Dam, 6.02. Under construction (track laid since Jan. 1, Sweetwater to La Presa, 186 miles.) Otay to Tia Juana, 5 miles. Projected, La Presa to El Cajon 6 miles. Chief Engineer, Jas. D. Schuyler, National City, Cal.

30. ***San Francisco, Clear Lake & Humboldt.***—Under construction, Napa, north, 25 miles. Projected, to Humboldt, 200 miles. President, W. H. H. Hart, San Francisco, Cal.

31. ***San Francisco & North Pacific.***—Under construction, Cloverdale to Ukiah, 30 miles, Pacheco to Napa, 12 miles.

32. ***San Francisco & San Joaquin Valley.***—Under construction, in San Joaquin Valley, 70 miles. President, J. R. Wilbur, San Francisco, Cal.

33. ***San Pedro, Los Angeles & Utah.***—Track laid, Raymond to Altadena, 7 miles. Located, San Pedro to Pasadena, 60 miles. Projected to California State line, 240 miles. President, J. P. Woodbury, Pasadena, Cal. Chief Engineer, J. M. Willard, Pasadena, Cal.

20. ***Southern Pacific.***—Track laid, Saugus to Elwood, 90 miles; Shingle Springs to Placerville, 12 miles;—California & Oregón Ry., end of track, to Ashland, Ore., 65 miles;—San Joaquin Valley R. R., Tracy, south, 40 miles. Under construction—Santa Rosa & Carquinez R. R., Napa to Santa Rosa, 20 miles;—Woodland, Capay & Clear Lake, Madison, north, 28 miles;—San Joaquin Valley Ry., end of track to Fresno, 110 miles;—Long Beach, Whittier and Los Angeles Ry., track laid since Jan. 1, Norwalk to Whittier, 20 miles; Wilmington to Long Beach, 10 miles. Surveyed, Elwood to Templeton, 155 miles. Under survey, Martinez to Livermore, 30 miles;—San Joaquin Valley Ry., about 200 miles.

New Projects and Surveys.

34. ***Fresno, Belmont & Yosemite.***—Under survey, Fresno, northwest, 50 miles. President, E. C. Winchell, Fresno, Cal. Chief Engineer, J. Tielman, Fresno, Cal.

35. ***San Diego & Cuyamaca.***—Projected, San Diego to Dos Palmos, 100 miles. President, R. W. Waterman, San Diego, Cal.

36. ***San Diego & Elsinore.***—Under survey, San Diego to Elsinore, 50 miles. President, Christopher Stevenson, Carson City, Nevada.

37. ***Yreka Branch.***—Surveyed, Yreka to Juliens, 10 miles.

Total.—Track laid, 377 miles. In process of construction, 598 miles. Under survey, 715 miles. Projected, 546 miles.

UTAH.

Existing Roads.

38. ***San Pete Valley.***—Under construction—California Short Line Ry., Chester to Manti, 15 miles.

3. ***Union Pacific.***—Track laid—Ogden & Syracuse R. R., Summit to Syracuse, 5.85 miles. Under survey, Milford to Barstow, Cal., 400 miles.

Total.—Track laid, 6 miles. In process of construction, 15 miles. Under survey, 330 miles. Projected, 200 miles.

COLORADO.

Existing Roads.

22. ***Atchison, Topeka & Santa Fé.***—Track laid—Denver & Santa Fé Ry., Pueblo to Denver, 116.8 miles. Pueblo & Arkansas Valley Ry., Clelland to Canon City, 6.8 miles, Brookside to Mine No. 7, 1.3 miles, Canon City to Mine No. 5, 1.7 miles.

1. ***Chicago, Burlington & Quincy.***—Track laid—Burlington & Missouri River R. R., Nebraska State line to junction with Cheyenne Ext. on Wyoming State line, 157 miles. Under construction, Nebraska State line to Holyoke, 24 miles. Surveyed, Kansas State line to Pueblo, 170 miles, Holyoke to Akron, 63 miles.

2. ***Chicago, Rock Island & Pacific.***—Under survey, Kansas State line to Colorado Springs, 150 miles. Projected, branches to Denver, Pueblo and Trinidad, and south to New Mexico, 250 miles.

39. ***Colorado Midland.***—Track laid, Manitou to Glenwood Springs, 215 miles; Aspen Jc. to Aspen, 19 miles; Cardiff to Jerome Park, 10 miles. Under construction, Glenwood Springs to Newcastle, 10 miles. Projected, Newcastle to Ogden, Utah, 300 miles.

40. ***Denver & Rio Grande.***—Track laid, El Moro to Trinidad, 4 miles; Red Cliff to Glenwood Springs, 66 miles; Glenwood Springs to Aspen, 42 miles; Montrose to Ouray, 35 miles. Under survey—Rio Grande & Pacific R. R., Glenwood Springs to Salt Lake City, Utah, 300 miles.

41. ***Denver, Texas & Fort Worth.***—Track laid, Pueblo to State line, 106 miles.

Missouri Pacific.—Pueblo & State Line Ry. Track laid, Kansas State line to Pueblo, 153 miles.

42. ***Silverton & Red Mountain Narrow Gauge.***—Track laid, Silverton to Chattanooga, 6 miles. Under construction, Chattanooga to Red Mountain, 5 miles, President, Otto Mears, Silverton, Col.

3. ***Union Pacific.***—Track laid—Colorado Central Ry., Loveland to Buckhorn stone quarries, 8.3 miles.

New Projects and Surveys.

43. ***Cortez & Dolores Valley.***—Surveyed, Cortez to Rico, 50 miles. Projected, Cortez to Durango, 65 miles. President, Burtis L. Arbecom, Boston, Mass. Chief Engineer, M. J. Mack, Cortez, Col.

44. ***Golden & Denver.***—Located, Golden to Denver and return, 30 miles. President, John C. Hodges, Jr., Golden, Col., Chief Engineer Edward L. Berthoud, Golden, Col.

45. ***Pueblo, Gunnison & Pacific.***—Projected, Pueblo west to Colorado State line with branches to Gunnison and Durango, about 450 miles. President, Chas. Henkel, Pueblo, Col., Chief Engineer, H. R. Holbrook, Pueblo, Col.

Total.—Track laid, 948 miles. In process of construction, 39 miles. Under survey, 638 miles. Projected, 865 miles.

NEW MEXICO.

Existing Roads.

22. ***Atchison, Topeka & Santa Fé.***—Projected, Texas State line to Las Vegas, 120 miles.

40. ***Denver & Rio Grande.***—Track laid, between Santa Fé and Espanola, 2½ miles.

Denver, Texas & Fort Worth.—Track laid, Colorado State line, southwest, 50 miles. Under construction (Track laid since Jan. 1.) end of track to Texas State line, 71 miles.

New Projects and Surveys.

46. ***Rio Grande & Utah.***—Surveyed, Algodones N. M., to Rico, Col., *via* Durango, Col., 275 miles. President, Jno. W. Conley, Rialto Building, Chicago, Ill.

Total.—Track laid, 53 miles. In process of construction, 71 miles. Under survey, 200 miles. Projected, 120 miles.

ARIZONA.

Existing Roads.

47. ***Arizona Mineral Belt.***—Track laid, Flagstaff to Fulton Canyon, 36 miles. Under construction, Fulton, south, 10 miles. Surveyed, end of grade to Globe, 134 miles. Projected, Globe to Benson, 175 miles.

48. ***Tucson, Globe & Northern.***—(Formerly Arizona Narrow Gauge.) Under construction, end of track to Gila river, 60 miles. Located, end of grade to Globe, 45 miles.

49 ***Maricopa & Phœnix.***—Track laid, Maricopa to Phœnix, 34.95 miles. Projected, Phœnix to Globe, 100 miles.

50. ***Prescott & Arizona Central.***—Under survey, Prescott to Phœnix, 110 miles.

Total.—Track laid, 71 miles. In process of construction, 70 miles. Under survey, 280 miles. Projected, 275 miles.

TEXAS.

Existing Roads.

(*The following list includes only lines within the limits of the Map. For complete list and Map of northern Texas,* see ENGINEERING NEWS of March 3.)

22. ***Atchison, Topeka & Santa Fé.***—Projected, across Texas Panhandle, 50 miles.

51. ***Austin & Northwestern.***—Under construction, Burnet to Lampasas, 20 miles.

2. ***Chicago, Rock Island & Pacific.***—Surveyed, State line to Cisco, 150 miles.

41. ***Fort Worth & Denver City.***—Track laid, Quanah to State line, 262 miles. Under construction, Washburn to Panhandle City, 16 miles. Projected, Fort Worth & New Orleans Ry., Fort Worth southwest to Louisiana State line, 275 miles.

52. ***Fort Worth & Rio Grande.***—Track laid, Fort Worth to Granbury, 40.2 miles. Projected, Granbury to Brownwood, 108 miles. General Superintendent, C. B. Colton, Fort Worth, Tex.

22. ***Gulf Colorado & Santa Fé.***—Track laid, Cleburne to Weatherford, 40 miles. Projected, Ballinger to San Angelo, 40 miles.

53. ***Missouri Pacific.***—Track laid—Taylor, Bastrop & Houston Ry., Bastrop to New Ulm, 55 miles; San Marcos to Stockholm, 16 miles. Under construction, between San Marcos and Sealey, 40 miles; New Ulm to Sealey, 23 miles;—Dallas & Hillsboro R. R., Dallas to Hillsboro, 65 miles; Lockhart to Smithville, 36 miles.

54. ***Rio Grande & Eagle Pass.***—Projected, Santa Thomas, north, 25 miles.

55. ***St. Louis, Arkansas & Texas.***—Track laid, Corsicana to Hillsboro, 40 miles. Under construction, Remer to Ft. Worth. Under survey, Gatesville to Llano, 90 miles.

56. ***San Antonio & Aransas Pass.***—Track laid, San Antonio to Kerrville, 70.5 miles. Cuero to Wallis, 90.5 miles; Yoakum to West Point, 49.1 miles. Under construction, Skidmore to Kleberg, 45 miles. Wallis to Houston, 45 miles. Located, West Point to Waco, 120 miles; Preliminary survey in progress, Kerrville to Cisco, 180 miles. Projected, Houston to Alexandria, La., and Natchez, Miss, 225 miles; near Yoakum to New Braunfels, 65 miles.

20. ***Southern Pacific.***—Projected, Victoria to Beeville, 60 miles.

New Projects and Surveys.

57. ***Austin & McGregor.***—Under survey, Austin to McGregor, 84 miles. President, Jos. Nalle, Austin, Tex.

58. ***Galveston Air Line.***—Projected, Galveston to Paris, 275 miles. President, W. L. Moody, Galveston, Tex.

59. ***Waco & Brazos.***—Under survey, Waco to Cameron, 65 miles. President, Wm. Cameron, Waco, Tex.

MEXICO.

Existing Roads.

Mexican Central.—Track laid, Irapuato toward Guadalajara, 61 miles. Under construction, to Guadalajara, 100 miles; between El Salto and Aguascalientes, 300 miles.

60. ***Mexican International.***—Track laid, Monclova to Torreon, 235.23 miles.

Mexican National.—Northern general division, track laid, Saltillo south, 20 miles. Under construction, end of track to San Luis Potosi, 220 miles. Chief Engineer E. A. Handy, Laredo, Tex. Southern general division under construction San Miguel de Allende to San Luis Potosi, 110 miles. Chief Engineer, H. H. Filley, 1,501 Holmes St., Kansas City, Mo.

Guadalupe Mining Co.—Track laid, Villadama to Rio Grande river, 25 miles.

New Projects and Surveys.

International Company of Mexico.—Surveyed, Ensenada, Lower California, to San Diego, Cal., and Yuma, Ariz., about 250 miles. Projected to San Quentin, Port Isabel and Chihuahua. President, Edgar T. Welles, Hartford, Conn. Directors, R. A. Elmer, New York City, Geo. H. Sisson, San Francisco, Luis Huller, City of Mexico.

Sewer Work.—The following proposals for the 3rd Div. of the general sewer system were opened March 20, by the Sewer Committee, Norwalk, Conn.; CHARLES N. WOOD Engineer. The contract was awarded to Francis Leonard.

	Pipe Outlet, 30 lin. ft.	30-in. Sewer in Concrete, 150 lin. ft.	30-in. Brick Sewer (railroad section), 25 lin. ft.	30-in. Brick Sewer (regular section), 90 lin. ft.	24-in. Cement Pipe Sewer, 1,150 lin. ft.	18-in. Stoneware Pipe Sewer, 2,964 lin. ft.	15-in. Stoneware Pipe Sewer, 1,070 lin. ft.	12-in. Stoneware Pipe Sewer, 5,424 lin. ft.	12-in Stoneware Pipe Sewer in Concrete, 150 lin. ft.	12-in. Stoneware Basin Outlets, 625 lin. ft.	Manholes, 84	Catch Basins, 26	Hubs (House Connections), 500	Solid Rock Excavation, 760 cu. yds.	6-in. Stoneware Pipe Connections, 192 lin. ft.	Total.
	$	$	$	$	$	$	$	$	$	$	$	$	$	$	cts.	$
Harris & Maguire, Brooklyn, N. Y.	6.00	12.00	8.28	3.95	2.75	1.95	1.50	0.98	1.63	0.98	40.00	73.00	1.50	4.10	25	28,308.32
Brady Bros., Bayonne, N. J.	6.60	11.55	7.50	3.60	2.65	1.92	1.35	0.98	1.29	0.87	45.00	75.00	1.50	4.00	18	28,124.21
Jas. J. Cogan, Bergen Point, N. J.	6.00	12.00	5.00	3.50	2.75	2.00	1.50	0.97	2.50	0.83	38.00	55.00	1.25	4.50	25	27,835.53
J. S. Bogert & Co., Brooklyn, N. Y.	6.25	12.00	4.25	3.50	2.50	1.50	1.25	1.00	1.20	1.00	38.00	75.00	1.30	4.25	30	26,245.75
Francis Leonard, Norwalk, Conn.	7.00	12.00	7.00	5.00	2.20	1.60	1.30	0.85	2.25	0.80	45.00	75.00	1.70	3.90	25	26,244.30

Contracting.

Depots.—*New York, Lake Erie & Western.*—The contract for the new depot at Niagara Falls, N. Y., has been awarded to W. A. Frazer, of Suspension Bridge.

Cincinnati Southern.—Work has been commenced on the new depot at Chattanooga, Tenn. H. C. Jackson is the contractor, and J. J. Fisher has a sub-contract for masonry.

Chesapeake & Ohio.—The contract for the new depot at Charleston, W. Va., has been awarded to R. Shore, of Huntington.

Cape Fear & Yadkin Valley.—A new passenger and freight depot will be built at Fayetteville, N. C.

East Tennessee, Virginia & Georgia.—The contract for the iron work of a passenger depot at Rome, Ga., has been awarded to the Birmingham Bridge & Bolt Works, of Birmingham, Ala.

The East Side Street Railway Co. has been organized at Brockton, Mass., with a capital stock of $45,000, and will build 4½ miles of road this season. It is probable that a careful investigation of the comparative merits of horse power and electric motors will be made. E. L. BROWN, of Brockton, is engineer for the company.

Pumping Engines, Pipe, Etc.—The following proposals have been received by JOHN CLAXTON, Chairman of the Water-Works Committee, Paisley, Ont., Canada: Osbourn Keilly & Co., Hamilton, Ont., engine, pumps and pipe complete, $5,650; McQuillan & Co., Toronto, engine, pumps, pipe and hose complete, $6,120; John Ronald, Brussels, Ont., engine, pumps, pipe and hose complete, $6,700; Jas. Smith & Co., Toronto, engine and pumps only, $2,120. The Committee recommended the acceptance of the bid of Osbourn Keilly & Co.

Court House.—The following were the proposals for the court house at Mayfield, Ky.: MCDONALD BROS., architects, Louisville, Ky.: M. T. Lewman & Son, Prather, Ind., $31,397; W. W. McCoy, Marietta, O., $31,480; Bailey & Koerner, Henderson, Ky., $34,800; J. L. Zeh, Cold Water, Ky., $46,867. The contract was awarded to M. T. Lewman & Son.

Street Paving.—The following proposals have been received by HENRY FLAD, President Board of Public Improvements, St. Louis, Mo.; Paving with pine wood blocks, treated with chloride of zinc; on 17th St. from Pine St. to St. Charles St. and from St. Charles St. to Washington Ave., respectively: Herman Ruecking, $12,591.70 and $2,536.75; Allen & Vieths, $13,503.44 and $2,729; Fred Skrainka, $13,734.64 and $2,774.20. The prices ranged as follows: taking up old paving, preparing road-bed, etc., $5 and $6 per sq. of 100 sup. ft.; new 4-in. curb, including setting, 88 and 90 cts. per lin. ft.; old curbing taken up and reset, 10 and 20 cts. per lin. ft.; hydraulic cement concrete, 6-in. deep, complete, $10 per sq. of 100 sup. ft.; pavement of impregnated pine wood blocks, $22.75 to $26.50 per sq. of 100 sup. ft.; maintenance per annum, 50 cts. per sq. of 100 sup. ft.——Asphalt paving on Locust St.; Barber Asphalt Paving Co., taking up old paving, preparing road-bed, etc., $3.50 per sq. of 100 sup. ft.; new 4 in. curb, including setting, 85 cts. per lin ft.; old curbing taken up and reset, 20 cts. per lin ft.; asphalt pavement on 6-ins. of hydraulic cement concrete, $30 per sq. of 100 sup. ft.; maintenance per annum, 50 cts. per sq. of 100 sup. ft.; total, $7,724.70

Granite paving; on Pine St., Herman Ruecking, $2,758.30; Stifel & Ruckert, $2,779.75; Fred Skrainka, $2,989.90; Allen & Vieths, $2,997.20; Julius A. Schneider, $3,027.40. ——On Carr St., J. A. Schneider, $12,945.35; Herman Ruecking, $13,463.50; Allen & Vieths, $13,938.20; Stifel & Ruckert, $14,220.50.——On Carr St., Fred Skrainka, $3,158.90; H. Ruecking, $3,288.20; Allen & Vieths, $3,439.24; J. A. Schneider, $3,473.73; Stifel & Ruckert, $3,477.20.—— On Cass Ave., Allen & Vieths, $50,169.30; F. Skrainka, $51,517.48; Stifel & Ruckert, $52,376.40.——On 6th St., F. Skrainka, $20,204.10; Allen & Vieths, $21,129.16; Stifel & Ruckert, $21,555.80.——On Broadway, Stifel & Ruckert, $50,211.85; Allen & Vieths, $51,817.82; F. Skrainka, $52,474.92.——The prices ranged as follows; taking up old paving, preparing road-bed, etc., $2 to $8 per sq. of 100 sup. ft.; furnishing and setting 4-in. curb, 80 to 90 cts. per lin. ft.; taking up and resetting old curb, 10 to 20 cts. per lin. ft.; hydraulic cement concrete, 8-ins. deep, complete, $10 to $12 per sq. of 100 sup. ft.; granite block paving, $30 to $35 per sq. of 100 sup. ft.

Lake Tunnel.—The following proposals for furnishing the materials for and building a tunnel under Lake Erie from the Division St. pumping station to the inlet protection crib, a distance of about 9,200 ft., were opened March 24 by the Trustees of the Water-Works, Cleveland, O. There will be five shafts, one for an inlet shaft in the lake crib, one working shaft near the lake shore and three at the pumping station, each to be 8 ft. clear diameter. All of the land shafts to be lined with cast-iron cylinders, 1½ in. thick for a depth of 36 ft. The inlet shaft to be of cast-iron, 2 ins. thick for a depth of 81 ft. JOHN WHITELAW is Superintendent and Engineer of the Water-Works. The contract was awarded to J. S. Casement & Co.

Proposals Open.

Bridge.—Across Deer creek, on existing brick piers. THE BRIDGE COMMITTEE, Oakley, Franklin parish, La.

Well.—Large collecting well for the water-works. D. S. SPAULDING, Chairman, Water Commissioners, Mansfield, Mass. April 3.

Pipe Sewer.—Vitrified pipe 450 ft., 3 manholes, 1 basin. JOHN HUNKELE, Street Commissioner, Newark, N. J. April 3.

Paving and Street Railroad Tracks.—Grading and repaving approaches to Pearl St. viaduct; also laying about 700 lin. ft. of double track street railroad on north portion of Central viaduct, "Johnson" girder rail. April 5.—Grading and Medina block paving on earth portions of Central viaduct; also furnishing rails for about 2,850 lin. ft. of double track street railway on the iron portion of viaduct, "Johnson" girder steel rails. WALTER P. RICE, City Engineer, Cleveland, O. April 19.

Bidders.	Tunnel per ft.	Inlet shaft.	1st working shaft.	2d working shaft.	Gate shaft.	Extension shaft.	Extra depth of shaft per ft.	Total.
J. S. Casement & Co., Painesville, O.	$18.00	$18,839.00	$5,762.07	$5,605.13	$6,447.35	$6,947.65	100.00	$204,301.16
McReynolds & Gannet, Cleveland, O.	22.00	8,000.00	3,800.00	3,200.00	3,000.00	3,000.00	50.00	223,450.00
Andrew Doll, Jr., "	21.00	14,297.00	6,500.00	6,000.00	5,000.00	5,000.00	150.00	230,147.00
W. Campbell, "	24.95	10,000.00	4,000.00	4,000.00	4,000.00	4,000.00	30.00	235,570.00
Scott & Downer, "	25.41	8,408.50	3,280.00	3,150.00	4,080.00	4,300.00	32.50	257,023.00
L. P. & J. A. Smith, "	26.25	10,800.00	6,000.00	5,000.00	5,354.00	5,354.00	250.00	274,258.00
Stanley Bros. & Co., "	27.50	9,800.00	3,800.00	3,800.00	4,800.00	4,800.00	48.00	280,048.00
Frank Rieley & Co., "	35.00	12,500.00	11,000.00	7,000.00	10,000.00	10,000.00	150.00	372,650.00

Water-Works.—About 17,000 ft. of 4 to 8-in. pipe; special castings; 37 hydrants; 50 gates, 4 to 8-in.; pumping machinery of from 1,000,000 to 2,000,000 galls. daily capacity. Specifications on file. B. V. SOULE, Recorder, Ovid, Mich. April 10.

Pipe and Pipe Laying.—Cast-iron water pipe, branch pipes, specials, stop-cocks, hydrants, boxes, etc.; also laying water mains. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City, April 11.

Sand and Gravel.—Clean sand for road surfacing, 1,200 cu. yds.; 2,200 cu. yds., of Roa Hook gravel; 3,000 cu. yds. of Roa Hook gravel bank screenings. THE COMMISSIONER OF PUBLIC WORKS, 31 Chambers St., New York City, April 11.

Bridge.—Over White river. Foundations and masonry; superstructure in 2 spans of 130 ft. 18 ft. roadway, total length between abutments, 365 ft. Bidders to furnish plans, specifications and strain sheet. THOMAS TAGGART, Auditor for Marion Co. Commissioners, Indianapolis, Ind. April 12.

Building.—Town hall, council chamber, prison, etc. MAX REUTTI, architect, Hamilton, O. S. E. MORTON, Town Clerk, Camden, O. April 16.

Jail.—Stone structure. W. A. SMITH, Corn Hill, Tex. April 16.

Public Buildings.—Court house and post office at Jefferson, Tex. WILL A. FERRET, Supervising Architect, Treasury Department, Washington, D. C. April 19.

Buildings.—For the Ohio Soldiers' & Sailors' Home. H. C. LINDSLAY, architect, Zanesville, O. R. B. BROWN, Secretary, Trustees of the Soldiers' & Sailors' Home, Sandusky, O. April 20.

River Improvement.—Construction of Lock No. 1, and excavating channel below in the Black Warrior river, near Tuskaloosa, Ala. Major A. N. DAMRELL, U. S. Engineer Office, Mobile, Ala. April 23.

Sewers and Sewer Material.—Constructing main, sub-main, lateral and house connecting sewers in Sewer District No. 1. Furnishing and delivering cast-iron pipe and specials, cast iron rings and covers for flush tanks, inspection pipes and manholes, etc.; pipe per ton, castings per pound. Furnishing and delivering first quality Portland and American cement. Furnishing and delivering at trenches first quality vitrified, salt-glazed sewer pipe and specials. (See advertisement). F. D. KITCHELL, Secretary, Board of Sewer Commissioners, East Liverpool, O. April 25.

Sewer Pipe.—At Manchester, N. H., the following proposals for furnishing sewer pipe to the city for the ensuing year were opened March 24: Frank B. Potter, Akron pipe, 45 per cent. off the list price; John B. Varick, Portland cement pipe, 60 per cent. off the list price; Pike & Heald, Akron pipe, 45 per cent. off list price; Henry Fisk, Akron pipe, 45 per cent. off list price, additional reduction of 2 per cent. off net bill for cash within 10 days; T. A. Lane, Akron pipe, 45 per cent. off list price, additional reduction of 2 per cent. from net bill for cash within 10 days; Pettee & Adams, Portland pipe, 45 per cent. off list price, additional reduction of 2 per cent. from net bill if paid within 10 days; Ohio Sewer Pipe Co., Columbus, Ohio, 45 per cent. off list price, additional reduction of 2 per cent. for cash within 10 days; Marcellus Day Company, 50 per cent. off list price; Thorpe & Bartlett, 45 per cent. off list price, additional reduction of two per cent. for cash within 10 days; Scotch imported pipe, C. A. Machsen, agent, 50 per cent. off list price. It was found that Henry Fisk, T. A. Lane and Thorpe & Bartlett had put in bids exactly similar for furnishing the pipe, and it was voted to divide the contract among the three. It was also voted to order through Pettee & Adams, two car loads of Portland pipe. The cement pipe for which J. B. Varick has the agency was favorably considered and an order will probably be given this season.

The Cleveland Stone Co., of Cleveland, O., issues a new catalogue and price list of buff amherst, berea and blue amherst, building stone, bridge stone, curbing, flagging, etc. There are 24 pages of views of the quarries and of public and other buildings for which the company has supplied stone.

Pipe, Hydrants, Etc.—The Water Commissioners, Buffalo, N. Y., have awarded contracts as follows: Buffalo Cast-Iron Pipe Co., 4, 6, 10, 16 and 20-in. pipe, $28.50 per ton delivered on the streets where required; Howard Iron Works, hydrants; Ludlow Valve Co., Troy, N. Y., valves; Bingham & Taylor, Buffalo, valves and service boxes; J. Lyth & Sons and Buffalo Sewer Pipe Co., tile, 55% off list prices.

Jail.—The County Commissioners, Lawrenceville, Ga., have awarded the contract for the new jail to the Pauly Jail Mfg. Co., of St. Louis, Mo.

Culvert Pipe.—Blackmer & Post, of St. Louis, Mo., manufacturers of culvert pipe, etc., have issued an illustrated pamphlet "Something about Culvert Pipe." giving a history of the use of this pipe for railroad purposes, instead of timber trestle work, iron pipe or cement pipe for small openings and waterways through embankments. The pipe is made in lengths of 30 ins. and the improved sockets make the joints the strongest part of the pipe line. The pamphlet contains a number of testimonials, a list of railroad and construction companies to whom it has been supplied, and a table of prices; also instructions for laying the pipe. There are also drawings of the standard culverts of the Kansas City & Omaha R. R. and of the parapet walls for pipe culverts on the Great Eastern Ry., Canada.

Bridges and Canals.

Miami & Erie Canal.—A project is on foot to interest Congress in the scheme for the enlargement of this canal, opening a passage for Government ships between the lakes and the Mississippi.

The Brazos River Channel & Dock Co. has been incorporated at Austin, Tex., by IRA H. EVANS, of Aus

tin; C. W. OGDEN, of San Antonio; JOHN M. FERGUSON, of Kansas City, Mo., and others, to construct and operate a deep water channel not less than 10 ft. deep, from the Gulf into the mouth of the Brazos, and to construct docks, etc. Capital stock, $1,000,000.

Bridge Notes.—***New York City.***—The bill for a bridge over the North river, at a point between 10th and 81st Sts., has been favorably reported by the Assembly committee.

Albany, N. Y.—A bridge or viaduct is proposed over the ravine at Hawk St.

Lockport, N. Y.—Mark Gilman, of Rochester, has erected the new Cottage St. bridge. It is 87 ft. long with a 22 ft. roadway and two 5½ ft. sidewalks.

Baltimore, Md.—A new iron bridge has been built over the railroad tracks at Charles St. It is 126 ft. long and 66 ft. wide.

Owensboro, Ky.—The Mattingly and Sugar Grove iron bridges have been completed by the Smith Bridge Co. and accepted by the county. The first has 2 spans, 160 and 90 ft.; the latter has 1 span of 100 ft.

Rockport, Ind.—A bridge is proposed across the river, to be built by Kentucky parties. A bill has been introduced in the Kentucky legislature to incorporate the Kentucky & Rockport Bridge Co.

Clarksville, Va.—A company is being organized to build a bridge over the Roanoke river. It will be about 1,700 ft. long.

Minnesota.—The Senate, at Washington, D. C., has passed a bill authorizing the construction of a bridge across the Red River of the North.

Sioux City, Ia.—The caisson of the 3d pier of the new Missouri River bridge has been sunk to the bed rock. Two other piers, on the Nebraska side, remain to be put in.

Menasha, Wis.—A bridge is to be built across W. C. Hewitt's mill race at a cost of $1,500. The city has paid $6,750 to Keeper & Riddell, of Milwaukee, for the Mill St. bridge.

Denver, Col.—The 14th St. viaduct is to be built at once. Proposals were opened March 26.

Oregon City, Ore.—A free bridge is to be built across the Willamette river. Plans for a cantilever bridge have been prepared by Hoffman & Bates, of Portland. The main span will be 440 ft.; total length of bridge, 935 ft.; roadway 20 ft. wide, 78 ft. above the water.

Windsor, Ont.—A bridge is proposed across the river to Detroit, either at Windsor or Sandwich. There are to be 3 swinging sections, left open for shipping except for trains to pass. The Detroit River Winter Railway Bridge Co. has been incorporated by WM. HENDRIE, GEO. HENDRIE, WM. THOMPSON, H. C. SYMMES, and others. Capital stock, $500,000. A similar company will be organized in the United States.

Ste. Martine, Ont.—The masonry of the bridge of the Beauharnois Junction Ry. across the Chateauguay river is completed and the Dominion Bridge Co. will erect the superstructure. James Wright was the contractor.

The Morris Canal.—The Common Council of Newark, N. J., has adopted resolutions directing the Legislative Committee to oppose the bill to authorize the Lehigh Valley R. R. Co. to cease the navigation of the canal, unless the company agrees to confirm to the city of Newark the use, without condition, of that portion of the property now occupied by the Center Market; the various bridges not to be kept in repair by the city; to drain the bed of the canal within the city limits under direction of the city authorities; that no use shall be made of the canal bed under the Center Market or west of Mulberry street within the city limits for railroad or transportation purposes except upon consent of the Mayor and Common Council of the city under such regulations as may be prescribed; and that the property of the said company within the city limits shall be subject to taxation for local purposes at local rates.

WATER.

New Brunswick, N. J.—GEO. HILL, C. E., of New Brunswick, writes us that the coffer-dam, which was built just west of the impounding dam washed out on Feb. 26, was washed out March 21; the cause being faulty design. This week a flood caused considerable damage to the preparatory work for the new permanent dam.

Waco, Tex.—The Citizen's Committee has adopted a report as follows: "We approve of the action of the City Council in contracting for cisterns as a temporary means of affording a water supply for fire protection. We recommend that a competent engineer be employed to devise a system of water-works adequate to supply the wants of a city of 40 000 people, and that bids be advertised for, and the contract let to the lowest responsible bidder who can execute a satisfactory bond. In the event that no private contractor can be found to construct such system, we recommend bonding the city for the purpose of building water-works. We further state that it is our opinion that the City Council has done all it can consistent with self-respect to make a contract with the Waco Water Company, and that further overtures should come from the Waco Water Company, and not from the city of Waco,

The Aransas City Harbor, Channel & Dock Co. has been incorporated at Austin, Tex., by R. E. MADDOX, T. P. PENOIR, T. P. MCCAMPBELL, of Fort Worth, M. BROWNSON, of Victoria, and others to construct and operate channels, docks, harbor, etc., in the vicinity of Aransas Pass.

Cucamonga, Cal.— Feb. 16, 1888.

EDITOR ENGINEERING NEWS:—The source of present supply is tunnels into volcanic hill 2½ miles below the Cucamonga mountains, and artesian wells in same hills; there are 5 reservoirs with capacities of 2,000,000 to 3,000,000 galls. each, and hydrant pressure is used for fire purposes. The works were built by the Cucamonga Water Co., and cost $200,000, including reservoirs, tunnels and pipe lines; capital was obtained by subscription. E. T. WRIGHT, of Los Angeles, was the engineer in charge. For all work proposed at present the contractors are Lacy, Ward & Co., and Edward Roe, both of Cucamonga; and the work will probably be completed in 2 years. The company supplies water for irrigation as well as domestic pipes, has now laid 25 miles of mains. The maximum pressure would be about 600 ft., but it is broken by a series of reservoirs. Water all distributed in pressure pipes for domestic supply. The population of the town is 300.

J. C. LYNCH, *President, Cucamonga Water Co*

Fall River, Mass.—Litigation is in progress between the city and manufacturing companies ttaking water from Watuppa pond. The Fall river is a non navigable stream, 2 miles long, into which flow the waters of the Watuppa ponds, the daily average being about 26,000,000 galls. The city in its valuation of the land on this stream, values the water power of the mill privileges at $344,000 and paid the parties owning them upwards of $50,000 by judgment of court for damages caused by the taking of 1,500,000 galls. daily of the waters of the North Watuppa. In 1886 an act was passed by the Legislature giving the city the right to take 1,500,000 galls. daily of the North Watuppa pond, without liability to any damages other than the State would be legally liable to pay. The plaintiffs claim that the city is now daily taking such a quantity of water as to cause substantial injury to their privileges on the Fall river. The defendant claims that it is not liable to any damages caused by the taking of the water. The plaintiffs assert that this claim of the defendant, pushed to its extreme, might result in the destruction of $340,000 worth of property, without the payment of a dollar. The city makes its claim on the ground that the Watuppa ponds are great ponds and belong to the State under the ordinance of 1647, and the State can therefore divert their waters, or grant to others the right to do so, without liability for any damage caused thereby.

Water-Works.—***Rhode Island.***—Burrillville. The Burrillville Water Co. has been organized under a charter granted by the Assembly. A meeting of voters will be held April 2 to consider the company's proposition to put in water-works.

Massachusetts.—Ware. Among the appropriations for the year is the sum of $3,000 for extension of the water-works.——Peabody. The city has appropriated $5,000 for the water-works and $2,000 for the extension of the same.

New York.—Brooklyn. A bill has been introduced in the State Senate to regulate the amount of water to be drawn from the rural Long Island sources by the city. The amount pumped out of Queen's Co. to be limited to 40,000,000 galls. per day.——West Troy. The water company's works will be purchased by the Green Island Water Co., in which Moffett, Hodgkins & Clarke, of Watertown, are interested. Gravel island will be used for filtering purposes and the pumping station will be in Green Island. The West Troy reservoir will be deepened and used for a distributing reservoir. ——Franklinville. Water-works are contemplated.—— Rochester. The Water-Works Committee will ask for an appropriation of $100 000 for the ensuing year.

Pennsylvania.—Reading. The Board of Trade has offered to furnish the capital necessary for procuring an additional supply, relying for repayment upon the surplus earnings of the Water Department. A pumping station will be erected at once.——Uniontown. The Uniontown Water Co. will build a 5,000,000 galls. reservoir at Cool Spring; this will give a total supply of 27,000,000 galls. from 3 reservoirs. The company has let a contract for 4 miles of 8 and 10-in. pipe to R. D. Wood & Co., and will shortly contract for pipe from the new reservoir to the city.

Ohio.—Ashtabula. It is reported that the Council has decided not to test or accept the works until the pipes are laid at the specified depth. (The dispute was explained on page 17).

Indiana.—Dixon. The City Council has decided to cease payment to the water-works company until the plant is in condition to afford the city protection against fire. The company has been receiving $5,000 a year from the city for furnishing water.

Kentucky.—Paris. The proposition to build water-works, made by J. E. THOMPSON, has been accepted, and a meeting to vote on the ratification of the contract will be held April 14.

Tennessee.—Tullahoma. A water company has been organized. Address GEO. W. DAVIDSON, for particulars.

Georgia.—Cedartown. A large reservoir is to be established at a sufficient elevation to give a fire pressure. Address Messrs. PACE & HERBERT.

Florida.—Kissimmee. The Kissimmee Water Co. has been organized; capital stock $40,000. President, CHARLES SWAYNE; Secretary, JOHN KING; Treasurer, J. M. BOWLING.

Alabama.—Tuscumbia. The American Well Co., of Aurora, Ill., will sink the 6 artesian wells for the new water supply.

Mississippi.—Natchez. The New Orleans *Times Democrat* says "the Board of Aldermen have by resolution decided to notify S. R. Bullock & Co. and their bondsmen that the contract for building water-works in this city will be declared forfeited on May 13 if the works are not completed according to contract."

Arkansas.—Camden. The Camden Water-Works Co. has been organized; capital stock, $30,000. President, S. Q. SEVIER.

Kansas.—Salina. The water-works are for sale. Address H. BAKER.—— Harper. The water-works built by J. W. HILL, have not yet been accepted.

Michigan.—Detroit. Residents of the northern part of the city complain of an inadequate supply of water and have petitioned for an improvement.

Illinois.—Galesburg. Judge GRESHAM has decided the case of the city against the Galesburg Water-Works Co. to annul the contract made by the city with the company to supply water. The ordinance was passed May, 1881, and gave the company the right to supply water both for city and private purposes. Under this contract the company built water-works, but failed to comply with the tests as to quality and quantity. It, however, supplied water for a year or more, when the city, having learned, as it claimed, that the company had been guilty of deception in the kind of water supplied, undertook to annul the contract, and took possession of the mains. The Judge said that the city was entitled to have the contract annulled for non-performance, but must pay a reasonable compensation for the water it received during the time the contract was in force. If necessary the case would be referred to a master in chancery to determine the amount due, and when it was paid a decree would be entered. While this case has been pending the company's works have been sold under a $150,000 foreclosure decree, and bought in by a purchasing committee on behalf of the bondholders.——Staunton. Work will be commenced shortly on the new water-works.

Nebraska.—Beatrice. The propositions for bonds for paving and for bonds to purchase a filter for the water-works have been carried. The injunction upon the letting of the sewerage contract was withdrawn. This will, therefore, allow three important public improvements, sewerage, paving, and the placing of a filter in the water-works, to proceed without delay. The water is taken from the Blue river and the supply is unlimited.——Lincoln. The new supply from the 80 driven wells was tested March 17 and 18. The amount pumped during the 24 hours test was 2,909,816 galls., but it is estimated that 3,500,000 galls. could have been pumped if the pumps had been worked to their full capacity. The old and new supply will aggregate 4,000,000 galls. per day.

Montana.—Fort Benton. The water-works have been completed and put in operation. Also an electric light plant. Both were put in by GEO. T. WOOLSTON.—— Butte City. The City Council has announced its willingness to grant exclusive privileges to any company that will supply the city with pure water. The present company may improve its supply.

Texas.—Cuero. Water-works are projected, also a water power canal; the supply to be obtained from the Guadalupe river. C. M. TERRELL, J. O. FRENCH, and others, are interested.——Brenham. According to a Galveston paper the contractor boring at the water-works has thrown up his contract with the company and gone home. The undertaking proved a bad job; the water was not there.

Iquique, Chili.—The Tarapaca Water-Works Co. has been incorporated in London, England, to supply water to Iquique and the surrounding districts from the springs at Pica and other sources. The company will acquire a concession granted by the Chilian Government, and has purchased springs at Pica; it will also purchase from Col. J. T. NORTH the land, offices, water-tanks, pipes, and other plant used by him for his water business at Iquique, together with the goodwill thereof; and his lease from the Company Proveedora de Agua (a company now existing in Iquique for the distillation of sea water by machinery) of their works and plant, which lease expires on the 31st day of March, 1892; and 157 shares of that company of $500 each. By the purchase of the above mentioned concession, property and rights, the company practically secures the control of the supply of water to Iquique.

The district to be supplied comprises the important seaport town of Iquique, the principal port for the ex-

port of nitrate of soda, and near which are the flourishing silver mines of Huantajaya and Santa Rosa. Iquique and the immediately surrounding district is devoid of any natural sources of water supply, and is dependent on distilled sea water and water brought in steamers' tanks from the port of Arica, 110 miles distant. A gravity supply of pure water at a moderate price is, therefore, urgently required. The population of Iquique has risen from 3,600 in 1862 to over 16,700 at the present time, while there are large numbers of consumers to be supplied at La Noria, Huantajaya, Santa Rosa, and other places in the vicinity.

In addition to the requirements for domestic purposes, there is also a great demand for water for the large number of mules and other animals employed in Iquique, and for traffic with the interior, as well as for public baths, mining, manufacturing purposes and shipping. The water is to be brought from springs at Pica, at the base of the Andes, about 60 miles inland, and 4,000 ft. above the sea level. The route selected passes close to the town of La Noria, and to the various stations on the La Noria and Iquique branches of the Nitrate Railways Co.

The conduits will be of cast-iron pipes. The main conduit will be capable of conveying 450,000 galls. of water per day, so as to admit of a large future increase of the supply. It is intended to lay down branch pipes to Pozo Almonte and to the mining districts of Huantajaya and Santa Rosa. Wrought-iron storage tanks, to contain in all 4,125,000 galls., will be provided at Iquique and along the line of conduit. The construction contract provides that the whole of the works shall be completed within two years.

The estimated consumption, including the railways, mines and neighboring villages, is 208,000 galls. per day The quality of the water is superior to that now obtained by the Nitrate Railways Co. at Arica. During the construction of the new works, the present system will be continued, the company having an interest therein. The contractor is Alexander Cochran. ROBT. HARVEY, A. M. I. C. E., is Chairman of the company; W. R. COPLAND, M. I C. E., of Glasgow, Scotland, is the Engineer, and A. D. BRYCE-DOUGLAS, is Consulting Engineer. Capital stock, $2,000,000.

RECORD OF NEW WATER-WORKS CONSTRUCTION.

(Specially Communicated.)

(CONTINUED FROM PAGE 238).

Bellevue, Idaho.—The works were commenced July 1, 1887, and completed about Oct. 31, 1887. The work was not done by contract; the pipe was furnished by the Puget Sound Pipe Co., of Olympia, Wash. Ter., and the valves and hydrants by the Union Iron Works, of San Francisco, Cal. The price paid for trenching was 10 cts. per foot; the pipe laying was done by day labor. The franchise is perpetual. The city levies a tax of ¼ of 1 per cent. on all property, to pay for the use of fire plugs. This pays cost of collection of rates and maintenance of works. The charter runs for 49 years. Cost of works, $15,000. Length of mains, 27,556 ft. The water is taken from a running mountain stream, 9,059 ft. distant from main street. Head of 150 ft. The works are paying 2% a month on the investment, and are exempt from the city taxation. The franchise is owned by the Bellevue Water Co.; President, H. E. MILLER; Secretary, H. F. BAKER; Superintendent, G. B. PINKHAM. The population in 1887 was 1600.

Belleville, Ont., Canada.—The works were commenced March 15, 1887, and accepted Feb. 6, 1888. They were designed by R. FREEMAN, of Watertown, N. Y.; F. S. PECKE, of Watertown, N. Y., was Consulting Engineer, and A. R. SHANNON, Superintending Engineer. The contract for the entire work was taken by Moffett, Hodgkins & Clarke, of Watertown, N. Y.; the other contractors were, for masonry and foundations, Wickett Bros., of Belleville; buildings, Walter Alford, of Belleville; pumping machinery, H. R. Worthington, of New York City; boilers, Inglis & Hunter, of Toronto; pipe and specials, Alex. Gartshore, of Hamilton, Ont.; valves and hydrants, Ludlow Valve Mfg. Co., of Troy, N. Y., (169 hydrants); iron stand-pipe, 35 ft. diameter and 120 ft. high, Canadian Locomotive & Engine Works, Kingston, Ont. The trenching and pipe laying was done by the day, under the supervision of A. R. SHANNON; the prices paid for labor being $1.25 to $1.50 for trenching, and $2 to $2.50 for pipe laying. The franchise is for 10 years, virtually perpetual; and the annual rental is $50 per hydrant. The franchise is owned by the Belleville Water-Works Co.; President, J. V. CLARK; Secretary, J. F. MOFFETT; Superintendent, GEO. H. POPE. The head office is at Watertown, N. Y. There are 15 miles of distributing mains and 2,000 ft. of 20-in. submerged pipe in the Bay of Quinte. There are 2 pumping engines of 2,000,000 galls. capacity each, 2 steel boilers of 80 H. P., a Worthington condenser and a No. 11 National feed water heater. The maximum static pressure is 79 lbs. from the tower and the mains are tested to 170 lbs. The population in 1887 was about 12,000.

Belfast, Me.—The works were commenced in June, 1887, and accepted in December, 1887. They were designed by Wheeler & Parks, 75 State St., Boston, Mass., who also had the contract. The pumping machinery was supplied by the Deane Steam Pump Co., of Holyoke, Mass.; the pipe by R. D. Wood & Co., of Philadelphia, Pa.; the specials by the Builders' Iron Foundry, Providence, R. I.; the valves and hydrants by the Coffin Valve Co., of Boston, Mass., and the stand-pipe by E. Hodge & Co., of Boston. The trenching and pipe laying was sublet to Ferris & Halladay, of Jersey City, N. J. The stand-pipe is 45 ft. high and 30 ft. diameter; the average static pressure is 85 lbs. The franchise is for 20 years and the price per hydrant is $45 per annum. The franchise is owned by the Belfast Water Co.; President, CHAS. J. GILMAN; Secretary, J. N. DRUMMOND. The present population is about 5,800.

(TO BE CONTINUED).

Special Reports of Water-Works Construction.

The fourth yearly edition of the *Statistical Tables of American Water-Works* will be published as the ENGINEERING NEWS' MANUAL OF AMERICAN WATER-WORKS, and the change of name will be accompanied by such an enlargement of the scope of the work and such improvements in its completeness and correctness, as will make the volume *indispensable* to every manufacturer, engineer and contractor in any way interested in Water-Works construction and maintenance, and of great value to Water-Works superintendents and projectors of new works

We are now receiving reports from all parts of the country for use in compiling this book, and abstract the news of immediate importance below. We trust our readers will kindly aid us in making the Manual of American Water-Works as complete as we desire, by notifying us of any new works under construction or projected, which they do not see mentioned in our columns. Blanks for reports of existing works or works newly projected will be sent on request.

CASTILE, N. Y., March 22, 1888.

EDITOR ENGINEERING NEWS:—We shall try to put in water-works here this season at a cost of from $10,000 to $12,000. It is proposed to take water from springs and pump it to a reservoir. Our population is 1,200. The work is projected by a private company.

J. H. VAN ANSDALE, *Prest.*

GUYANDOTTE, W. Va., March 17, 1888.

EDITOR ENGINEERING NEWS:—I enclose all the information I have been able to obtain regarding our proposed water works. The ordinance granting the franchise to the Guyandotte Water Co. was passed by the Village Council March 13, and at once accepted on the part of the grantees. Either D. J. SMITH, Mayor: T. E. STOUT, Huntington, W. Va., one of the incorporators, or myself, can give further information. The proposed source of supply is the Ohio river. Either the direct-pressure system will be used, or water will be pumped to a reservoir. The works will cost about $100,000 and the capital has been secured by the sale of the company's stock. The plant is to derive its running power from the Huntington (W. Va.) Water Co., and is to be built in connection with those works. Guyandotte joins Huntington at the eastern limits of the latter.

B. J. WILSON, *Recorder City Council.*

NORFOLK, Neb., March 19, 1888.

EDITOR ENGINEERING NEWS:—The Norfolk Water-Works Co. will build works at an estimated cost of $50,000. The proposed supply is from a system of bored wells, from which water will be pumped to a stand-pipe. Our population is 3,500. The President of the company is C. E. CLARK; the contractor, A. L. STRANG, Omaha Neb.

W. EVERECK.

Through the courtesy of J. H. ROBBINS, Supt., Pendleton (Ore.) Water-Works, we learn that the City Council of Baker City, Ore., is discussing the water-works question. At present they are making inquiries concerning the most suitable material for water mains. J. I. DONNELLY, Auditor of Baker City, Ore., are be addressed.

BENICIA, Cal., March 6, 1888.

EDITOR ENGINEERING NEWS:—The Benicia Water Co. has just added $80,000 to its capital stock, and a new gravity dam of 200 million galls. capacity will be built at once. T. McKAY is President.

E. A. MIZNER, *Supt. Benicia Water Co.*

DULUTH, MINNESOTA, March 23, 1888.

EDITOR ENGINEERING NEWS:—Enclosed I send you a form filled out with the information required for your MANUAL OF AMERICAN WATER WORKS. We are preparing to make several extensive improvements in our works this season, consisting of the following: A new reservoir at an elevation of 285 ft. above Lake Superior. A set of Worthington compound duplex pumping engines, capacity 3,000,000 galls. daily. Two tubular boilers. The laying of from 4 to 6 miles of cast-iron mains in sizes from 6 to 20 ins. The building of a new brick smoke stack, and the further extension into the Lake of our intake pipe. In our gas plant we construct an entire new works, and lay from 4 to 6 miles of cast-iron pipe in sizes of 4 to 16 ins. In our new gas-works we propose to have the latest and most improved machinery now used, and to adopt the best system of making gas now in vogue.

WM. CRAIG, *Supt. Duluth Gas & Water Co.*

NIAGARA FALLS, Ont., March 26, 1888.

EDITOR ENGINEERING NEWS: The old water-works plant here was built by the Niagara Falls Water-Works Co. about 1856, and bought by the town in 1884. It is now run to its utmost capacity, and fails to meet the demand. The town propose to put in new works, and voted to raise $57,000 for that purpose last year. Some defect in the measure makes a second vote necessary.

J. ROBINSON, *Sec. Water Commissioners.*

Annual Reports.

Kalamazoo, Mich.—A copy of the annual reports of the several city officers and committees has been sent us by CHAUNCEY STRONG, City Clerk, but as the reports are for the year ending in April, 1887, the statistics contained therein are not of much present interest. The total amount pumped was 557,170,404 galls. The distribution system comprised 111,437 ft. of 2 to 20-in. pipe, 203 hydrants, and 180 gates. The report of GEO. S. PIERSON, City Engineer, gives particulars of prices for city work. The reports are bound together in pamphlet form, making a very handy collection of interesting data.

Jacksonville, Fla.—The Trustees of the Sanitary Improvement Bonds have issued their report for the year ending June 30, 1887. The revenue from the water-works was satisfactory, and although considerable outlay will be required for extensions it is hoped that this revenue will, in a short time, pay the interest and sinking fund of the city's bonded debt. A system of automatic flush tanks for the sewers was recommended, to lessen the cost and increase the efficiency of flushing. The reclamation of certain swamps was recommended in the interest of the sanitary condition of the city. The total consumption of water was 335,181,510 galls. The supply from the artesian wells remained constant, about 2,419,000 in 24 hours; the only effect of the earthquake was to make well No. 2 throw out some lumps of blue clay for a few weeks. There were 287 meters, and 100 additional were recommended. The superintendent reported that the consumption of water was very near the limit of the economic pumping capacity, and that it would be necessary to run both pumps together, to get a new pumping engine, or to erect a stand-pipe; he made some remarks on the comparative merits of stand-pipes and tanks built on towers, and recommended an iron or steel tower supporting 2 tanks, one about 90 to 100 ft. above the ground, with a capacity of 90,000 to 100,000 galls., and a second one 210 ft. from the ground, holding 30,000 to 40,000 galls.; the lower tank for ordinary service and the upper one for fire pressure. Additional sewers were recommended. R. N. ELLIS, C. E., is Superintendent.

Camden, N. J.—The City Surveyor, JOHN S. SHULTS, and the Supervisor of Highways, JOHN BLOWE, have issued their joint report of work done from July, 1887, to February, 1888, being their first annual report. The sewer work was as follows the prices given being the average:

Sewers, 11,776.43 ft.,	at $1.83	$21,691.60
Inlets, 37	at $57	2,109 00
Manholes, 52	at $8	416.00
Terra-cotta pipe, 684 ft.,	at 85 cts	581.40
Terra-cotta bends, 46	at $2.63	120.98
Cleaning and repairing sewers, etc.		1,200.02
		$26,119.00

The table of street paving gives the amount and cost of different classes of work on each street.

Pawtucket, R. I.—The Water Commissioners have issued their report for the year ending Dec. 1, 1887, being the 8th annual report. The Diamond Hill reservoir was completed in October and the Happy Hollow dam in November. The growth of the city and increased consumption of water has necessitated greater pumping facilities and a site for a new pumping station has been selected on the east bank of the Blackstone river; the water will be taken through a 36-in. conduit from Happy Hollow pond to the filter gallery, whence it will be pumped direct to the distributing pipe and Stump Hill reservoir. During the year 16,377 ft. of pipe were laid, total 98 miles; 25 hydrants were put in, total 778; 256 meters were put in, total in use 2,834. The total amount pumped at the two existing stations was 1,159,310,518. EDWIN DARLING is Superintendent.